Railway Age Gazette

DAILY EDITION

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VOLUME 58 JUNE 12, 1915 NUMBER 24b

PUBLISHED EVERY FRIDAY AND DAILY EIGHT TIMES IN JUNE BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY
WOOLWORTH BUILDING, NEW YORK

CHICAGO: Transportation Bldg. CLEVELAND: Citizens' Bldg.
LONDON: Queen Anne's Chambers, Westminster.

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Subscriptions, including 52 regular weekly issues and special daily editions published from time to time in New York, or in places other than New York, payable in advance and postage free:

United States and Mexico.....$5.00
Canada 6.00
Foreign Countries (excepting daily editions)..... 8.00
Single Copies .....15 cents each

Engineering and Maintenance of Way Edition and four Maintenance of Way Convention Daily issues, North America, $1.00; foreign $2.

Entered at the Post Office at New York, N. Y., as mail matter of the second class.

WE GUARANTEE that of this issue 10,011 copies were printed; that of those 10,011 copies 8,572 were mailed to regular paid subscribers to the Railway Age Gazette and the Railway Age Gazette, Mechanical Edition; 150 were provided for counter and news companies' sales; 189 were mailed to advertisers; 100 were provided for bound volumes, and 1,000 for distribution at Atlantic City.

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The training of enginemen is a serious problem on all railways. If it is to be done properly it requires patience, tact and a knowledge of human nature on the part of the man in charge. Such a man cannot be chosen at random; he must be selected only after a careful appraisal of the qualifications of all likely candidates. The road foreman needs all the qualifications of the successful educator; his duties include the hiring and training of men whose work intrusts them with the care of many human lives, and to satisfactorily perform such duties he must be of the proper temperament, otherwise he may do more harm than good. The right kind of man as road foreman, given absolute charge of the hiring of firemen and the training of both firemen and enginemen, and held responsible for the development of the highest class of men, can produce remarkably gratifying results.

Qualifications of a Road Foreman

The convention of the Master Mechanics' Association which closed yesterday was unusually successful. The reports seem to be more carefully prepared, particularly with a view to conciseness, and there are a number of them which reflect more than ordinary credit on the members of the committees. Three of those deserving of special mention are the reports on Fuel Economy and Locomotive Counterbalancing and Boiler Washing. The discussions were not as full in some cases as they might have been, but on the other hand the members seemed, for the most part, to know pretty well what they wished to say, and said it without consuming too much of the convention's time. The individual paper on Variable Exhausts will prove a valuable addition to the proceedings of the association. The topical discussions were selected with evident care and it was unfortunate that there was not time to go into a full discussion of all of them, as they were timely and worthy of very careful attention on the part of the entire membership.

A Successful Convention

Almost any one can prepare an elaborate chart showing a system of organization, but the ability to prepare it does not make the organization effective in practice. To be most effective an organization requires at its head a man who will deal with it as would the father of a family. We recently heard it said that the reason for the success of a certain superintendent of motive power lies mainly in his ability to choose men of reliability, and then let them see by his actions that he is not afraid to place confidence in them. His predecessor was disliked and had not the confidence of his subordinates because he did not place confidence in them, but employed a number of officers who acted practically as spies. No man can expect to build up an effective and efficient organization by such methods. The man who places confidence in those whom he appoints as subordinate officers and shows them that he is interested in their success, can feel sure of their co-operating with him and furthering his efforts at all times.

Treatment of Subordinates

Anyone who travels frequently is familiar with the comment of passengers on the rough handling of some of our passenger trains, especially at starting. With the very long and heavy trains, now so common in fast through service, it is often impossible for an engineman to get under way without taking the slack at least once, so that many of the annoying shocks are almost, if not quite, unavoidable, at least under present conditions. However, there is some of this rough handling that is inexcusable, particularly in the case of the shorter trains. Many enginemen are careless in judging their stops at stations, bringing the train up with a final brake application that is likely to throw passengers off their feet. In a large measure, the correction of this abuse lies in the hands of the road foreman of engines. Carelessness due to lack of supervision is directly responsible in many instances and the road foreman has it in his power to promote a better feeling among the road's patrons by giving closer attention to the instruction of the enginemen under his jurisdiction.

Rough Handling of Passenger Trains

ELECTION OF R. S. M. A. EXECUTIVE MEMBERS

THE Railway Supply Manufacturers' Association is a business organization. Therefore, sound business principles should govern in the choice of its officers. The district meetings will be held today for the election of four members of the executive committee. As a business proposition, the only thing which should be considered in determining the selection of these executive committee men is their fitness to contribute their share toward making the work of the association as efficient as possible. The executive committee appoints the chairmen of the various committees; they, in turn, appoint the members. In order that the work of the association may be kept going properly, the members of the exhibit, entertainment, enrollment and other committees must devote much time and energy to their duties. Therefore, they should be

selected with great care. When this has been done, the members of the committees, and especially their chairman, will naturally be the best fitted, by experience and other qualifications, for election to the executive committee, and should, therefore, be elected to it. Furthermore, if good timber is put on the executive committee, it will follow that this committee will afford the best material from which to select the higher offices of the association.

In other words, good business suggests that, as far as practicable, civil service rules be followed, and that those who render the best service on the subordinate committees be promoted to the committee chairmenships and to membership on the executive committee; and that, in turn, those who give the best service on the executive committee be given the honor, opportunity and responsibility of the vice-presidency and the presidency. There is always danger of politics working in, and over-riding, business considerations in the affairs of the Railway Supply Manufacturers' Association. This always will do harm. When the members cast their votes today for executive members, they should remember that the application of sound business principles will always promote the efficiency of the organization, while the intrusion of politics will always interfere with its efficiency.

LIGHT RECIPROCATING PARTS

THE committee on counterbalancing deserves a great deal of credit for the high character of the report presented at Friday morning's session. The tables which accompanied the report of those which appeared with the series of articles on Reciprocating and Revolving Parts, by H. A. F. Campbell, now appearing in the *Railway Age Gazette, Mechanical Edition,* to which reference was made in the report of the committee, give convincing proof of what is common practice and of what can be done, in the way of reducing the weight of reciprocating parts. The column showing the piston load carried per pound of weight of reciprocating parts is eloquent of the poor practice which has been so commonly employed, but it will be seen from these tables that the desirability of having these parts as light as they could be made was realized by some roads many years ago and consistent efforts made ever since to keep their weight to a minimum in new power. If this report were to accomplish nothing else it should be the means of setting some of our mechanical engineers thinking along the right lines.

The evidence submitted by officers of the Pennsylvania as to the service of the heat treated parts used in their latest locomotive designs disposes in a convincing manner of the idea that lightness and strength cannot be combined, and when we consider the weights now being carried on single driving axles, we cannot but agree with the committee in the statement that the lighter the reciprocating parts can be made the better the results which will be obtained. The racking and disturbing effects of improperly balanced locomotives traveling at high speed were clearly brought out by S. G. Thomson, superintendent of motive power and rolling equipment of the Philadelphia & Reading, and chairman of the committee, in his closing remarks, and we agree thoroughly with him in his reasoning that cost should be left out of consideration in any efforts to obtain the lightest possible parts, at least for locomotives in high speed passenger service, as any extra cost will very soon be absorbed by the decrease in maintenance expenditure. The work of producing improved materials for accomplishing just such purposes is receiving greater impetus every day and there is no reason why the same degree of refinement should not be obtained in locomotive practice as is now the case in automobile construction.

Undoubtedly careful attention must be given to the matter of heat treating when this process is employed for improving the quality of steel, as the very best material is absolutely necessary when reciprocating parts are made as light as those in recent locomotives built for the Philadelphia & Reading, the Pennsylvania, and the Burlington; but railway men have got to learn that there are many things about locomotive design, construction and operation that are going to require much greater care in the future than they have ever before received. Mr. Thomson's concluding statement of the text of the committee's report is a good one—make the reciprocating parts as light as possible and the undesirable counterbalancing effects will be reduced to a minimum.

COST OF CONDUCTING TRANSPORTATION

MECHANICAL department men are usually keenly alive to the necessity for keeping expenses at the lowest possible point, but they are not always interested as much as they should be in the matter of expenses outside their immediate department. Practices in the motive power department have a direct bearing on the cost of conducting transportation. Motive power that will haul the greatest tonnage with the least amount of expense for fuel and upkeep is, of course, one of the principal factors in reducing transportation expenses. If a careful study is made of the conditions of operation when deciding on new power, it will be found that the after-effects in the way of reduced expenses due to increased tonnage and reduction in the overtime of train crews amply justifies the time and money spent in making such a study. Overtime has become a prominent factor in increasing wage expenditures, and the question of supplying engines that will get maximum tonnage trains over the road within the time limit, ought to be given an important place in considerations pertaining to new locomotives or alterations to old ones.

The time which it is necessary to hold a locomotive out of service at terminals is of vital importance to the operating department and depends to a great extent on the equipment of engine houses, the suitability of their arrangement for the quick and easy movement of locomotives without interfering with one another, and the size of the force employed. One of the worst causes of delays at engine terminals is insufficient coaling and ash-handling facilities, causing locomotives to stand for long periods awaiting their turn for coaling and fire cleaning before entering the engine house so that actual repairs can be begun. Of course, an engine house foreman by the exercise of ingenuity and good judgment can do much to offset inferior equipment and poor location of a roundhouse, but he can use his ingenuity to much better advantage in a properly equipped plant, and the advantage in the movement of trains which results from the speedy return to service of locomotives after they arrive at a terminal, while beyond definite calculation, is very considerable. Careful attention to both back shop and roundhouse repairs has a direct bearing on the cost of conducting transportation. Slipshod methods in general repairs will invariably cause heavy running repairs and the greater the amount of such repairs the longer the locomotive must remain in the engine house between trips. Moreover, unless repairs are given the attention which they should have, engine failures will increase rapidly and the effect of an engine failure in demoralizing train movements is well known. It is difficult to imagine any saving which might be effected by skimping on running repairs, which could be claimed to justify even the most trivial engine failure.

Of course, the greatest portion of the cost of conducting transportation is chargeable to fuel and, while much has been said in these columns on this subject, it should not be amiss to call further attention to the great need of effecting every possible economy in fuel consumption. The kind of training which enginemen receive affects fuel consumption in a very direct way, and a lack of proper training also affects transportation expenses injuriously, because of improper locomotive handling.

TODAY'S PROGRAM

SATURDAY, JUNE 12, 1915

10:30 A. M.—Orchestral Band Concert. Entrance Hall, Million Dollar Pier.

3:30 P. M.—Orchestral Band Concert. Entrance Hall, Million Dollar Pier.

9.00 P. M.—Vaudeville Entertainment. Million Dollar Pier.

RAILWAY CLUB SECRETARIES

The annual meeting of the Society of Railway Club Secretaries will be held at 10 o'clock this morning in room 193 of the Blenheim.

DYNAMOMETER CAR

The Southern Railway is exhibiting its new dynamometer car at the track exhibit at Mississippi Avenue, two blocks south of the pier. The car is in working condition and contains a number of new and interesting features.

ATLANTIC CITY ROTARY CLUB

The Rotary Club of Atlantic City will hold its weekly luncheon at the Hotel Schlitz, Tuesday, June 15, at 1 P. M. James S. Murphy, city passenger agent of the Pennsylvania Railroad is chairman of the entertainment committee and will be glad to have any visiting Rotarian attend the luncheon.

TODAY IS R. S. M. A. ELECTION DAY

The annual meeting of the Railway Supply Manufacturers' Association, for the election of officers and the transaction of such other business as may be brought up for attention, will be held at 12 o'clock noon today in Convention Hall, Million Dollar Pier.

The voting for four members of the executive committee will be done in the room at the front of pier adjoining Mr. Conway's office. The polls will be open from 10 a. m. to 12 noon. The vacancies in the committee to be filled are: one from the first district, succeeding Fred. M. Nellis, of Boston; one from the second district, succeeding Oscar F. Ostby, of New York; one from the fourth district, succeeding J. C. Whitridge, of Columbus, Ohio, and one from the seventh district, succeeding S. M. Dolan, of St. Louis.

In both instances each member is entitled to one vote, to be cast by the person registered with Secretary Conway as the authorized delegate, the residence of that delegate to determine the district in which he may vote. Voting may be done by proxy; but only written instruments, signed by someone with authority, will be accepted. The place of residence of the voting delegate registered with the secretary will determine the district in which a proxy vote may be cast.

THE CARNIVAL DANCE

The carnival dance held last night proved a great success. A good deal of mystery seemed to be attached to this affair, in that it was a new feature on the program. In consequence, everybody came early so as not to miss anything—and the moment that Leader Richardson raised his baton at 9.30 things broke loose. At 10.30 the entertainment committee distributed 30,000 rolls of serpentine, rubber balloons and novelties and scores of paper hats and caps. Immediately the air was filled with a storm of streamers, formality was swept away and from then on the whole became as one big happy family on a picnic.

Thoughtful as ever of the pleasure of those attending, the dance committee interspersed old dreamy waltzes and lively two-steps with the more modern numbers so everyone could participate. Owing to the sudden illness of W. K. Krepps, chairman of the committee in charge, who was taken with tonsilitis Wednesday, A. B. Wegener took his place and was ably assisted by Langley Ingraham, J. F. A. Comstedt, C. D. Jenks, G. R. Berger, R. J. Faure, C. D. Eaton, C. C. Farmer, A. MacRae.

THE GOLF TOURNAMENT

The following persons have registered for the golf tournament, in addition to those mentioned in yesterday's Daily. Others desiring to enter may leave their names at the *Railway Age Gazette* space today or at the Sea View Club early tomorrow morning.

W. L. Allison	Hinsdale G. C.
George L. Bourne	Wykagyl
J. S. Coffin	Englewood
C. C. Elmer	Berkshire
C. E. Fuller, Jr.	At Omaha
W. W. Griswold	Highland Park
C. C. Hopkins	Shaker Heights
J. M. Keller	Algonquin
D. M. Knox	Jackson Park
J. D. Purcell	Westward Ho
Fred Schaff	Lawrence Pk.
G. W. Spear	Englewood
W. J. Tollerton	Ridge
Alex. Turner	Englewood
R. H. Weatherly	Englewood

Sea View Golf Club House Showing the New Wing at the Right

Master Mechanics' Association Proceedings

Includes the Reports on Counterbalancing, Forging Specifications, Boiler Washing and the Concluding Exercises

President Gaines called the meeting to order at 9.40 o'clock a. m.

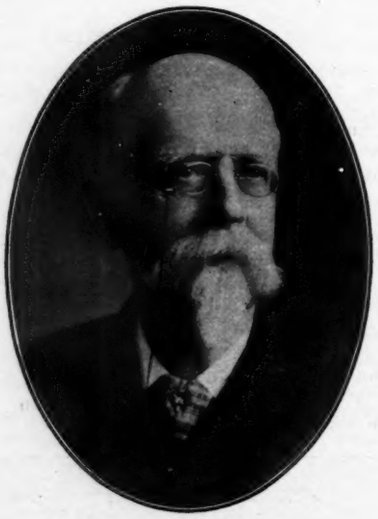
VARIABLE EXHAUSTS

By J. Snowden Bell.

[The author presented an interesting description of the various variable exhausts used from 1803 to the present time. From lack of space we are compelled to omit those invented prior to 1901.—Editor.]

The Olsen variable exhaust consists of two flexible "adjusting plates," the lower ends of which are fixed to a bridge piece in the exhaust nozzle, and which are spread outwardly, to reduce the discharge outlet, by an interposed transverse shaft, which is flattened centrally and operated by a rod. The plates are returned to their normal position, in which the maximum discharge outlet is given, by their own elasticity. This variable exhaust is shown in Fig. 1. In the construction shown, the discharge outlet is variable between a maximum area corresponding to a diameter of 6 in., and a minimum area corresponding to a diameter of 4½ in. This nozzle has been used on the Canadian Pacific and the Duluth & Iron Range but is not now in service.

Wallace & Kellogg Variable Exhaust, 1903.—This design is shown in Fig. 2. The front and rear sides or "doors" of the exhaust nozzle are hinged to it at their lower ends, and are simultaneously moved toward and from each other, to diminish or



J. Snowden Bell
Paper on Variable Exhausts

increase the area of discharge outlet, by a double grooved cam, which is rocked by an arm connected to the reverse lever. The grooves of the cam engage pins on the hinged "doors." This design was applied on the Pere Marquette and Duluth & Iron Range, and W. L. Kellogg reports that it was used for several years with very good results, and that tests with a dynamometer car proved that by its use the efficiency of the engine was increased and material saving in coal effected.

Baker Variable Exhaust, 1912.—Another variation of structure is shown in Fig. 3, from which it will be seen that the design consists of two co-acting "nozzle gates" or valves, which are pivoted to the top of the nozzle and are swung horizontally toward and from each other, with a consequent decrease or increase of discharge outlet area, by a transverse shaft, having right and left hand threads engaging threaded sleeves coupled to the nozzle gates. This variable exhaust was applied and used for about a year and a half on the St. Joseph & Grand Island, with the result which is stated as follows by C. E. Slayton, assistant superintendent:

"The adjustable feature worked well, that is, we were able to keep it in working order without any trouble. They did not effect saving enough to warrant us in applying them to more locomotives."

As was early recognized, and as is familiar to all who have had experience with variable exhausts, the greatest objection that has been developed in their operation is their liability to become gummed up and stuck fast by the action of foreign matter and the heat of the smokebox, unless frequently moved from one adjusted position to another, and if manually adjusted, such movement is liable to be, and generally has been, neglected. To overcome this objection, automatically adjustable appliances have been proposed, the Wallace & Kellogg appliance before described being an instance. This is connected to the reverse lever and is operated when the lever is moved.

While a number of the variable exhaust appliances before noted have been experimented with, and have, in some cases,

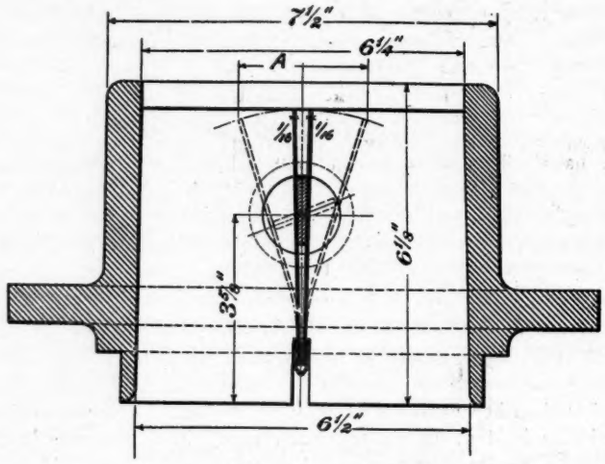


Fig. 1.—Olsen Variable Exhaust

been found to effect an economy in fuel, none of them has been considered to be sufficiently satisfactory or desirable to be retained in use. In Europe the early introduction of the variable exhaust has been followed by its general application, and it is understood by the writer to be standard to-day in the practice of leading French railroad systems, and probably also in other countries of Europe. A description and illustration of the latest type used on the Chemin de Fer du Nord, of France, have been furnished by Geo. Asselin, chief engineer of that road, and is presented as representative of the most approved design of present European practice The following is quoted from Mr. Asselin's letter:

"The plan view of this device is shown in Fig. 4. The con-

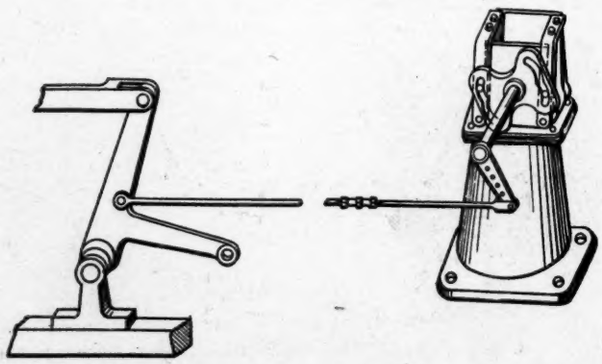


Fig. 2.—Wallace & Kellogg Variable Exhaust

traction of the exhaust is regulated by the height of the interior movable nozzle. The latter is controlled by a forged finger on the exhaust moving shaft, which extends across the smokebox in the ordinary manner. The engineman operates the movement by means of a hand-wheel and a screw; he has in sight a graduated scale which indicates to him the degree of contraction.

"From the point of view of ease of taking down and cleaning of the different parts, and of their perfect centering, this head has given entire satisfaction; but it was necessary to study the

result as a draught apparatus, by experimentally verifying its proportions and its forms.

"When the exhaust is contracted, whether the head be valved or circular, the effect is that the jet, while increasing in speed, is reduced more and more, and, therefore, fills the stack less and less. It was, therefore, thought that it would be possible to avoid this imperfection by imparting a movement of rotation to the exhaust jet, in order to maintain the same degree of

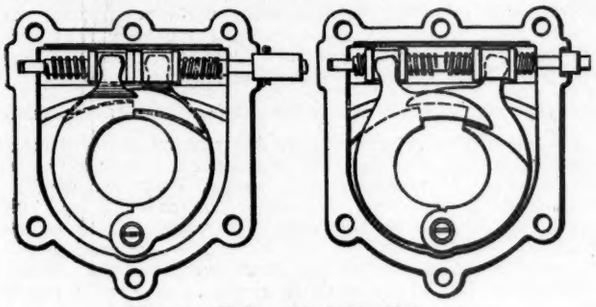


Fig. 3.—Baker Variable Exhaust

efficiency, whatever may be the degree of contraction of the exhaust. This end has been attained by the helicoidal wings.

"As a matter of fact, the exhaust jet expands as much more as the section of the exhaust head is more reduced, and, consequently, as the speed of the steam is greater. It follows that the gaseous column always completely fills the stack. Furthermore, this movement of rotation, due to the wings, augments the intimacy of the mixture of steam and hot gases, and communicates to it a greater quantity of live force. It has also been immediately recognized that, with equal section of passage of

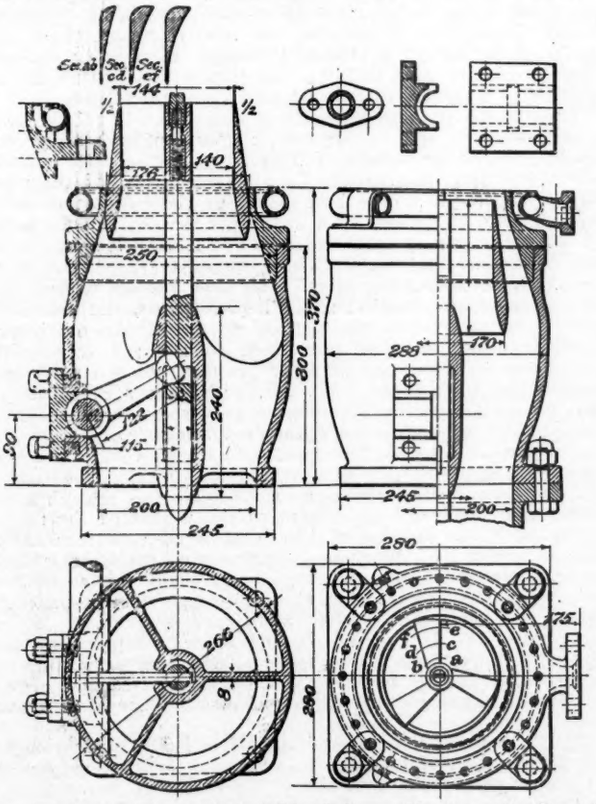


Fig. 4.—Latest Type of Variable Exhaust Used on the Chemin de Fer du Nord

the steam in the exhaust head, the draught was noticeably increased by this last arrangement.

"The character of the steam equally plays an important part in the question of the exhaust, and from the first application of superheating on the 'Atlantic' engines it has been recognized that it was necessary to choke the exhaust much more (nearly 15 per cent) to obtain the same useful effect. This new exhaust, giving at the same time a more intense vaporization and less back pressure, permits us to attain higher speeds by providing more facility for the management of the fire, or to augment the loads hauled by providing a more easy management of the boiler. As practical result I confine myself to saying that we have increased by 35 tons (say a car, with trucks) the load originally fixed as a limit for our fast trains."

The theoretical advantage and possible practical value of the variable exhaust have not been denied in the replies of motive power officers to the writer's inquiries, and the tenor of these replies is that its failure to be generally adopted in railroad service is largely, if not altogether, due to the fact that, under existing conditions, it does not seem possible to ensure it proper attention and protection from misuse on the part of engine crews.

The view of the writer as to the variable exhaust is to the same general effect as those of members of the Association and others who have expressed their ideas to the author, and he has brought this subject before the Association in the hope of sufficiently indicating its importance, to enlist the interest of the members and their consideration of the advisability of its development in their service. If this interest and consideration be given, there is no room for doubt that a variable exhaust can be produced, in which the requirements called for in the replies of the members would be fully complied with—that is to say, it would be "properly constructed," would be "automatically operable," and would be "fool-proof," because independent of the "human factor." Under the present conditions of railroad operation, the claims of this, as of every other appliance which is designed to operate in the direction of economy of fuel, merit a careful consideration on the part of motive power officers, and the standard of intelligence and ability of locomotive engineers at this time is so high that it would be unfair to them to believe that an appliance of such character, if approved by their superiors, would fail to receive fair and unprejudiced treatment in the operation of their locomotives.

DISCUSSION

C. A. Seley: While in the West recently I saw a device which Mr. Bell mentioned as having been developed by Mr. Mertscheimer, and that gentleman is quite enthusiastic over the device, believing, although not having made a scientific test of it, that he will save not pounds, but tons of coal.

D. R. MacBain, (N. Y. C.): I believe that until we get a variable exhaust that will work automatically, and almost humanly, we had better stick to a sure thing and make the nozzle large enough to keep the engine steaming and go along on that basis. The practical way at the present time to insure good locomotive service is to make the locomotive, when it is turned out of the shop, as nearly foolproof as it can be made, because if you depend on any person, other than the men who make the mechanical arrangements for you, you are going to lose on the proposition. My own personal experience has been that the thing to do is to make the nozzle as large as consistent and at the same time so design the nozzle so that the steam column will pass it without raking the sides of the stack in any direction. When you do that you allow space around the circumference of the steam column for the gases to be entrained and carried out. We have found that the exhaust steam left the top of the stack at a pressure of about five pounds. When you come to consider that you have five pounds pressure in a solid column of steam it is rather inconsistent to believe that any quantity of the front end gases are going to crowd themselves into that column of steam and be carried out, so what you have to figure on is a column of steam of great enough circumference to entrain a sufficient amount of gases per minute in order to create the desired draught. On the New York Central, west of Buffalo, out of many thousand locomotives operated our steam failures for the year 1914 were 46, and 146 failures were due to leaking.

W. E. Symons: The exhaust nozzles of locomotives, regardless of whether or not they are saturated steam, compound or superheater engines, is the medium that offers the back pressure to the pistons and therefore controls in a large measure the economical operation of the machine. It is a feature that should have been included in the field of investigation in the work of developing an economical machine. I have known of instances where an engine with but 25,000 lb. tractive power, equipped with a variable exhaust nozzle, could, by adjusting the nozzle, increase its power from 800 to 1,000 h. p. I have seen some statements made by one of the leading railroads of this country where the back pressure on certain engines was as much as 800 h. p.

JOINT MEETINGS

The Committee on Joint Meetings of the two associations presented a tentative program based on the work to be done at the 1915 Convention, to indicate how the two conventions could be held in one week. At the joint session which would be held on Wednesday, several reports which are common to both Associations were scheduled for discussion as follows: Safety Appliances; Revision of Standards and Recommended Practice;

Revision of Air Brake and Train Air Signal Equipment; Car Wheels, and Revision of Rules of Interchange, including Arbitration Committee Report. Revision of Prices for Labor and Material.

It is possible that other reports might also be added. The Committee itself believes some such a plan feasible, but would not recommend that it be done, believing that much better results are obtained from these conventions by following the present plan of holding each convention separately.

The report is signed by:—J. F. De Voy, (C., M. & St. P.); C. E. Chambers, (C. of N. J.), and C. F. Giles, (L. & N.), Committee A. R. M. M. Assn., and R. W. Burnett, (C. P. R.); J. S. Lentz, (L. V.), and T. H. Goodnow, (C. & N. W.), Committee M. C. B. Assn.

TRAIN RESISTANCE AND TONNAGE RATING

The committee has, in accordance with instructions, endeavored to get additional information to enable it to submit a final report at this convention. While some information has been available, yet the committee desire additional data as to the comparison of the drawbar pull curve of superheater locomotives, as compared with that of saturated locomotives. Data is also desired as to the resistance of the ninety-ton cars now coming into use. The committee will be able to obtain the information desired and submit a final report to the Association in 1916, and would ask permission to carry over the final report to that time.

P. F. Smith, Jr. (Penn. Lines), chairman; W. E. Dunham (C. & N. W.); J. S. Sheafe (B. & O.); H. C. Manchester (D., L. & W.); C. E. Chambers (C. of N. J.); J. H. Manning (D. & H.), and Frank Zeleny (C., B. & Q.).

COUNTERBALANCING

The following report will consider only the counterbalancing of two-cylinder locomotives, the three and four cylinder locomotives being less of a problem on account of the reciprocating parts more or less balancing each other.

GENERALLY ACCEPTED RULES AND PRINCIPLES.

The reciprocating parts to be considered in counterbalancing are: The piston head, rod and nut; the cross-head, cross-head key, pin and nuts; approximately one-half the total weight of the main rod; arm and link fastened to cross-head for outside valve gear.

Each driving wheel should have sufficient weight added to counterbalance exactly the weight of its revolving parts, which

S. G. Thomson
Chairman, Committee on Locomotive Counterbalancing

are: Crank pin, crank-pin hub, and the proportion of the weight of the side rods attached to the pin. The main driving wheel should have added approximately one-half the total weight of the main rod, plus two-thirds the weight of the eccentric arm, considered acting at crank pin distance, for outside valve gear.

The overbalance which is used to counteract the desired portion of the weight of the reciprocating parts should be distributed as nearly equally as possible among all driving wheels, adding to it the weight of the revolving parts for each wheel.

Centrifugal and reciprocating forces are usually figured at a speed in miles per hour equal to the diameter of the driving wheel in inches, which may be considered as a maximum for good practice. This is ordinarily referred to as "diameter-speed." At this speed the reciprocating parts, due to the laws of inertia, tend to continue their motion at the end of each stroke with a force about equal to 40 times their weight.* The overbalance exerts a centrifugal force equal to about 40 times its weight, and is at a maximum at the top and bottom position of the crank. This force is added to the static weight, in the lower position of the overbalance, and is opposed to this weight, in the upper position. Approximately one-fortieth of the static weight on a wheel will therefore give the weight of the reciprocating parts which could be balanced without causing the wheel to rise from the track at diameter-speed.

METHODS FOR DETERMINING THE AMOUNT OF OVERBALANCE.

The method most generally used for many years in counterbalancing locomotives has been to balance a portion of the total weight of the reciprocating parts, usually about two-thirds.

A second method, and the one recommended in the 1896-97 reports to the Master Mechanics' Association, is to leave unbalanced, on each side of the locomotive, a portion of the reciprocating parts equal to $\frac{1}{400}$ of the weight of the locomotive.

Neither of the above methods seems to give good results in all cases, and the committee presents another relationship which seems paramount to proper counterbalancing: The ratio of the total weight of the reciprocating parts on each side of the locomotive to the total weight of the locomotive in working order.

To show the necessity for this ratio, and to demonstrate the failure of the former rules when applied to locomotives with heavy reciprocating parts running at high speed, the committee made some tests on the Philadelphia & Reading, as shown in the accompanying table. These tests included a series of high-speed locomotives having very heavy reciprocating parts, equal to $\frac{1}{139}$ of the total weight of the locomotive.

One of this series of locomotives, No. 345, had 69 per cent of the reciprocating parts balanced, and was so rough at high speed that many parts of the locomotive were being continually shaken loose, thus disproving the rule requiring about two-thirds of the weight of the reciprocating parts to be balanced. This locomotive also had $\frac{1}{447}$ of its total weight unbalanced, which also disproves the second method of calculation.

Three more of these locomotives, Nos. 346, 341 and 347, were counterbalanced with 64 per cent, 55 per cent and 48 per cent, respectively, of the weight of their reciprocating parts balanced, which was $\frac{1}{385}$, $\frac{1}{308}$ and $\frac{1}{266}$ part, respectively, of their total weight unbalanced. The best riding of these locomotives was No. 341, with 55 per cent or a little more than half of the weight of its reciprocating parts balanced. But this locomotive had too much fore and aft motion at moderate speed, due to the very heavy reciprocating parts. This fore and aft motion, however, was largely absorbed at the higher speeds, and a considerable vibration, due to the vertical forces of the overbalance, took its place; showing that, with such heavy reciprocating parts, even as low a portion as 55 per cent was too much overbalance for high speed. No. 347, with 48 per cent balanced, was not so bad in its vibrations at high speed, but had an excessive fore and aft motion at the moderate speeds.

The test of No. 345, therefore, with 69 per cent of its heavy reciprocating parts balanced as mentioned above, shows that it is the overbalance which makes a locomotive rough at high speeds, rather than too great an amount of the weight of the reciprocating parts left unbalanced. In other words, the fore and aft or nosing effect of unbalanced reciprocating parts seems to become absorbed, in passing through the moderate speeds, and the overbalance then becomes the disturbing factor at the higher speeds in setting up excessive vibration.

Locomotives 342 and 301, having lighter reciprocating parts and with 72 per cent balanced, seem to be well proportioned to prevent fore and aft movement, but the large percentage of overbalance necessary to accomplish this makes them rough at very high speed.

It will be noted that locomotives 341 and 301, which ride very much the same at high speed, have $\frac{1}{308}$ and $\frac{1}{808}$ part, respectively, of their total weight unbalanced; showing that this method of calculation is not reliable for the higher speeds. It will be noted, also, that the dynamic augment for these two locomotives is about the same.

It would therefore seem, from the above results, that the riding of a locomotive at high speed can be greatly improved

*The dynamic augment varies with the stroke.
If W = overbalance or excess weight at stroke distance.

then	with	18-in.	stroke,	dynamic augment = 29.1 × W	at	diameter-speed.
then	with	20-in.	stroke,	dynamic augment = 32.3 × W	at	diameter-speed.
then	with	22-in.	stroke,	dynamic augment = 35.5 × W	at	diameter-speed.
then	with	24-in.	stroke,	dynamic augment = 38.5 × W	at	diameter-speed.
then	with	26-in.	stroke,	dynamic augment = 41.7 × W	at	diameter-speed.
then	with	28-in.	stroke,	dynamic augment = 44.9 × W	at	diameter-speed.
then	with	30-in.	stroke,	dynamic augment = 48.4 × W	at	diameter-speed.
then	with	32-in.	stroke,	dynamic augment = 51.7 × W	at	diameter-speed.
then	with	34-in.	stroke,	dynamic augment = 54.9 × W	at	diameter-speed.

by reducing the weight of the overbalance. This can be done either by increasing the amounts left unbalanced, or by reducing the total weight of the reciprocating parts.

With a view of determining what proportion of the reciprocating parts can be left unbalanced, the counterbalancing of 345 was changed to 30 per cent balanced and 70 per cent unbalanced, which, for these very heavy reciprocating parts, represented excessive conditions, shown by the fact that as much as 1/198 of the total weight of the locomotive was unbalanced, instead of 1/400 as per the former rule. This locomotive had excessive fore and aft movement, too great for service even at low speed, but had no perceptible vibration due to vertical forces at high speed.

A second test was made with the 301, with 50 per cent of the weight of the reciprocating parts balanced, which was equal to 1/341 part of the weight of the locomotive. This gave better results that any of the tests with locomotive having the heavier reciprocating parts.

We can conclude from the above tests that the lighter the reciprocating parts can be made, the better results will be obtained. We can also conclude, when counterbalancing for very high speed, that a larger portion of reciprocating weights can be left unbalanced than has been the practice.

RESULTS OF COUNTERBALANCE TESTS ON THE PHILADELPHIA & READING.

Number	Type	Wheel	Weight of Engine	Weight of Recip. Parts	Recip. Wts. Wt. of Eng.	Reciprocating Parts Balanced Weight	Balanced %	Unbalanced Weight	Unbalanced %	Unbal. Wt. Wt. of Eng.	Static Weight per Wheel	Dynamic Augment per Wheel	% Inc. Weight 80 M.P.H.	Remarks
345	4-4-2	80"	224000	1616	1/139	1115	69	501	31	1/447	32250	23500	72	Very Rough at High Speed
345	4-4-2	80"	224000	1616	1/139	485	30	1131	70	1/198	32250	10220	32	Excessive Fore and Aft
345	4-4-2	80"	224000	1521	1/147	760	50	761	50	1/294	32250	16027	49.7	Fore and Aft Fairly Rough at High Speed
346	4-4-2	80"	224000	1616	1/139	1034	64	582	36	1/385	32250	21800	67	Rough at High Speed
341	4-4-2	80"	224000	1616	1/139	888	55	728	45	1/308	32250	18750	58	Good Average Rough at High Speed
347	4-4-2	80"	224000	1616	1/139	773	48	843	52	1/266	32250	16350	50	Fore and Aft Fair at High Speed
342	4-4-2	86"	222500	1370	1/162	985	72	385	28	1/578	31750	18425	58	Good Average Slightly Rough at High Speed
301	4-4-2	80"	217000	1273	1/170	916	72	357	28	1/608	30500	19300	63	Good at Low Slightly Rough at High Speed
301	4-4-2	80"	217000	1273	1/170	636	50	637	50	1/341	30500	13426	44	Good Average Good at High Speed

Plate 1

CONCLUSIONS.

A simple counterbalancing rule expressed in general terms, which should give good average results when applied to any class of locomotives in any service, might be stated as follows: Keep the total weight of the reciprocating parts on each side of the locomotive below 1/160 part of the total weight of the locomotive in working order, and then balance one-half the weight of the reciprocating parts.

The above general rule is based upon diameter-speed, and should keep the dynamic augment well within the limits of good practice. Where the normal speed is regularly considerably below the diameter-speed, it may be desirable to increase the proportion of the reciprocating weights to be balanced, to as much as 60 per cent or 65 per cent.

Another counterbalancing rule is, to set an arbitrary percentage which the dynamic force of the overbalance will be allowed to increase the static weight; for example:

If it is desired that the dynamic force of the overbalance at diameter-speed should not increase the static weight on a wheel more than 50 per cent, calculation could be made as follows:

4-4-2 type locomotive with 26-in. stroke.
Given: Static weight on one wheel = 30,000 lb.
To find: Maximum permissible weight of reciprocating parts to be balanced in one wheel = W.

$$W = \frac{\text{50 per cent static weight on one wheel} \times .312}{\text{Crank radius in inches.}}$$

$$W = \frac{15{,}000 \times .312}{13} = 360 \text{ lb.}$$

Therefore: The total reciprocating weight to be balanced on one side of this locomotive would be 720 lb. And with 50 per cent of the total reciprocating parts balanced on one side, the total weight of these parts must be designed to weigh 1440 lb.

The converse of this is:
Given: Weight of reciprocating parts balanced in one wheel, W = 360 lb.
To find: Dynamic augment = A.
A = W × 3.2 × crank radius in inches.
= 360 × 3.2 × 13 = 15,000 lb.
Therefore: 15,000 lb. dynamic weight is added to the 30,000 lb. static weight, giving a total of 45,000 lb. on the rail.

The dynamic augment may be expressed in percentage of the static weight on one driving wheel. These static weights, dynamic augments and percentage increases in weights are given as illustrations in connection with tests shown, where it will be seen that the percentage increase varies from 32 per cent to 72 per cent. The committee, however, believes that 50 per cent increase in the static weight on the driver at diameter-speed would represent good average practice, while much less than this percentage is greatly to be desired.

The committee concludes, therefore, that the secret of proper counterbalancing for any class of locomotive in any service is to reduce the weight of the reciprocating parts as far as possible.

Great benefit will be obtained if the railroads will determine the maximum load that they can carry on the rails, bridges, etc., and then reduce the weight of the reciprocating parts to a point where the dynamic augment of the parts balanced will be only a small proportion of this maximum allowed load.

Special designs of piston heads, cross-heads, hollow piston rods, and the use of high-grade materials, including heat-treated carbon and alloy steel, aluminum, etc., make it possible to construct very light parts, the expense of which will be many times justified by the consequent saving in repairs to equipment and track, as well as the saving due to the increase in tractive power of the locomotives. With a refinement of design along these lines, it is altogether possible to construct reciprocating parts approaching in lightness 1/240 part of the total weight of the locomotive in working order, instead of 1/160 part as expressed in the previously mentioned general rule representing a fair average. With an increased tendency toward these very light parts, the percentage of parts balanced or unbalanced becomes less and less a factor. Greater efficiency is thus given to the locomotive, in that more and more of the weight allowable on the rail will be used in starting and pulling the train.

The committee wishes to acknowledge its indebtedness to members of this Association, and others, who have furnished data; to the *Railway Age Gazette*, for the use of data contained in an article published therein by H. A. F. Campbell; and to George R. Henderson, who kindly offered his services to the committee; all of which assisted greatly in the preparation of this report.

The report is signed by:—S. G. Thomson, (P. & R.) Chairman; S. M. Vauclain, (Bald. Loco. Wks.); F. J. Cole, (A. L. Co.); John Purcell, (A. T. & S. F.); W. H. V. Rosing, (S. L. & S. F.); O. C. Cromwell, (B. & O.), and T. W. Heintzleman, (So. Pac.).

DISCUSSION

M. H. Haig, (A. T. & S. F.): Much of the information in the report bears on the reduction of weight of the reciprocating parts. Reference to light parts makes the strength of material a pertinent factor in the discussion of this

report. I fully agree that there is benefit to be gained by light reciprocating parts, and the consequent reduction of the counter balance weights in the wheels. If we can get material which will justify the parts being light it will then be practicable to design them of small size, but to do this and at the same time prevent engine failures requires that the material must be durable. Reference was made to the light parts in the locomotives built in 1914. Some locomotives built in that year have already had some of their parts break, and it would be interesting if we could find out to what extent there have already been breakages of the parts of some of the other engines, no doubt investigated by this committee. Many locomotives delivered by the builders are required to be re-counterbalanced after they have reached the various railroads. I know it to be a fact that some locomotives which have been re-counterbalanced according to the two-thirds method have given much more satisfactory results after having been re-counterbalanced according to that method. Because of my experience along that line it does occur to me that balancing only one-half of the weight of the reciprocating parts is too little.

William Elmer (Penn.): The committee recommends the application of the counterbalance at a point directly opposite the crankpin. It is my understanding that in some quarters it is the practice to slightly advance the counterbalance, so that it is not at a point directly opposite the crankpin.

C. D. Young (Penn.): We have a large number of high speed passenger engines in which the relation of the weight of the locomotive to the weight of the reciprocating parts is 230. In order to obtain as high a figure of the weight of the locomotive to the weight of the reciprocating parts, I believe it is necessary to heat treat the reciprocating parts. On these engines the piston rods are hollow, the pistons are rolled steel, the cross heads are made light by the use of electric cast steel, there is a hollow crankpin, and the lever is attached directly to the crankpin, with the union member attached. These have been in service now almost two years and we have not received in our department a record of any broken parts so far. There is a great deal of lightening accomplished by design, of course, in that hollow rods and pins are used, and a design of crosshead was used which was very light for its bearing area. I believe that the members can very safely lighten up the parts both by design and material, if the material is closely supervised when it is being treated.

J. E. Pilcher (N. & W.): I have in mind an investigation I made some years back of a peculiar knock that occurred on an engine in which the reciprocating parts were very heavy. In making the investigation the curve of the piston load was plotted from indicator cards, a definite speed and a corresponding pressure curve for the reciprocating parts was laid out, and we discovered for the first three inches in the stroke at that particular speed, the crankpin was pulling the reciprocator parts. That is, the curves crossed at 3 in. of travel. That illustrates the effects of the very heavy reciprocating parts and the necessity for reduction. Of course that is an example of how not to do it.

Mr. Thomson: I think any type of locomotive today could be designed without spending very much money in refinements and stick to the 1-180th part of the locomotive for the total weight of the parts, but the committee thought, to be very conservative in that matter, they would simply figure it 1-160th, to represent good average conditions. The figures vary on freight built locomotives, built before 1904, from 203 down to 144, and after 1904 from 199 to 134. Now, anybody building a freight locomotive with the reciprocating parts weighing 1-134th part of the locomotive is going to have trouble regardless of how much they balance it. Those figures will not require exceptionally light parts and the use of very high grade material. When you get up to 1-240 then you do have to use high grade, heat treated material, and have to resort to the very best designs. But I believe it can be done, and done very profitably to the railroads.

I do not think the matter of heat treated parts or the cost should have entered our heads, because it is a matter of a few dollars, and it will pay for itself the first two or three years you bring it into the shop. The contention about our not being able to get results with heat treated steel and the refinement of parts I do not think should be considered. In regard to the knock that some people will find in an engine, this is not always due to the counterbalancing. There are a great many other things that make an engine rough, besides faulty counterbalance. If the weights are less, the engine will be very rough, and the higher the speed the worse it will be. The question of preadmission and cushioning the parts are all very pertinent to the subject, and it resolves itself back again to the point that the important thing is to make your parts light—that seems to be the fundamental text of the report this year.

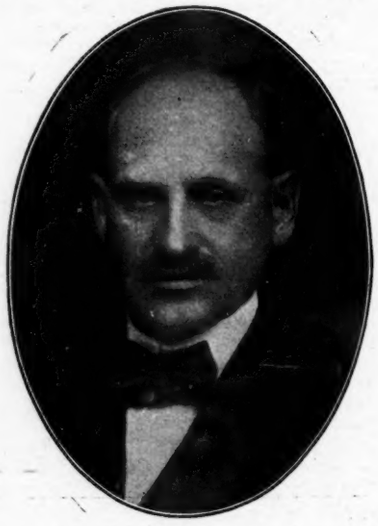
MAINTENANCE AND OPERATION OF ELECTRICAL EQUIPMENT

An adequate idea of the extent to which steam railroads have electrified is given in the accompanying table, corrected to January 15, 1915. Summarized, it shows electrification on parts of 14 steam railroads, to the extent of 591.3 route miles, including 1761.65 miles of track.

All of the members of the committee making this report are responsible for the maintenance of electric equipment on steam railroads and four of them acquired their experience in the steam motive power department. In general, the committee considers that experience in maintaining steam equipment is the best possible training for the new responsibilities, about the only additional requirement being an ability to understand and use intelligently the necessary electrical terms. This is not difficult.

A study of the plans of shops designed and built by two steam railroads especially for the maintenance of their electric equipment shows that they are equally well adapted to the repairs of either steam or electric equipment; and of the tools used almost all are necessary for the maintenance of steam equipment alone. This should convince the most skeptical that no master mechanic who is successfully maintaining steam rolling stock need hesitate to undertake the maintenance of electric equipment.

In connection with the experience with electrification, the following list shows the additional tools which were found neces-



C. H. Quereau
Chairman, Committee on Maintenance and Operation of Electrical Equipment

sary for handling the electric equipment at one shop which was originally equipped only for the maintenance of steam equipment:

One 190-ton portable hydraulic press for removing crank pins from discs, and discs from motor shafts.

A hook for lifting the front end of the locomotive.

A lifting beam for motors. It is necessary to have a lifting beam for removing and replacing motors.

A lifting beam for removing and replacing cabs.

A special chuck for boring jack shaft and motor bearings.

A tension device for re-bending armatures. The armatures are all bended on a driving wheel lathe, and this machine is placed conveniently in order to maintain a constant tension on the banding wire, the tension being indicated on a scale in pounds.

An insulation testing transformer consisting of a 3-kw. transformer mounted on a truck with voltmeters for testing from 200 to 6000 volts, and is used for testing armatures and fields for grounds.

A cradle for holding armatures after removing them from the locomotives when it is not necessary to work upon them.

A feature worthy of note in connection with the maintenance of steam and electrical equipment will be found in the comparatively small machine tools and light cranes installed in electric locomotive repair shops. The reason for this is the relative lightness of the individual parts of the electric locomotives. Another feature is that, on the average, the age of the employees in an electric equipment shop is less than in a steam equipment shop. One reason for this is that the maintenance of electric equipment on steam roads is a comparatively new business, and has been in existence too short a time to have employees grow old in the service.

One might easily assume it is essential the workmen have a rather extensive electrical training, and it is true that a mainte-

nance organization should have one or two electrical experts, mechanics rather than engineers. However, experience has shown that at least 90 per cent of the work to be done and of the problems to be solved are mechanical. Aside from the inspection, the maintenance is taken care of in the regular steam railroad repair shops.

There is this characteristic difference between steam and electric equipment. With steam locomotives it takes about five minutes to locate a defect and from a day to a week to make repairs; with electric equipment it takes an hour or two to locate the cause of the trouble and from five minutes to a day to repair the defect.

At the time of introduction of electric operation on any railroad, the usual plan is to qualify the regular steam locomotive engineers and firemen for service on the electric locomotives. A few days' instruction by a qualified traveling engineer and a few trips over the road under his supervision are sufficient. To those without the experience, this statement may appear fanciful, but as a matter of fact it may be accepted without question.

A little consideration will convince even the most skeptical that a knowledge of the Book of Rules, the significance of signals and train orders, experience in handling the air brakes and an intimate knowledge of the territory constitute at least nine-tenths of the qualifications of an efficient engineman. These are the same for electric and steam operation. The operation of electric equipment is much simpler than for steam locomotives. The motorman does not have his vision blinded or confused by smoke or steam, coal dust or ashes; his attention is not distracted by watching the steam gage or water glass, or instructing his fireman in his duties, nor is he bothered by balking injectors, ash pans or leaky flues. There are, of course, no stops for coal and water and there need be no long wait between trains for cleaning fires or ash pans.

Numerous statistics relating to electrically operated roads have been published, including the cost of labor and material expended in repairs, and to the efficiency of the apparatus and the maintenance methods as shown by the number of delays. Several of these statements use as a basis for judging the efficiency of the equipment and its maintenance the unit "Miles per Detention," and also the unit "Miles per Minute Detention," but the majority of the statements published do not show the former item. For the operating officials the unit "Miles per Minute Detention" is of decided value, but this is not the proper basis on which to judge the efficiency of the apparatus nor of the force that maintains it, because the length of the delay is affected in most cases more by operating conditions than by the nature of the failure originally causing it.

It appears to be advisable, therefore, to consider only the unit "Miles per Detention" in connection with the records of the maintenance department, and it seems also to be desirable to subdivide the causes of train delays due to electric equipment under three headings: "Man Failures," "Electrical" and "Mechanical." The headings "Electrical" and "Mechanical" are self-explanatory. The other heading "Man Failures" is intended to cover failures of equipment which are due to the men operating it.

The report is signed by:—C. H. Quereau (N. Y. C.), Chairman; G. C. Bishop, (L. I.); G. W. Wildin, (N. Y., N. H. & H.); J. H. Davis, (B. & O.), and R. D. Hawkins, (G. N.).

DISCUSSION

G. W. Wildin (N. Y. N. H. & H.): We think we have about the best electrical repair shop in the United States for electric locomotives. Of course, there is in our shop some very peculiar machinery designed especially for the peculiar equipment we have on that road—I presume we have the most complicated electrical equipment there is in the United States—and for that reason perhaps we do not make as many miles per detention as some of our neighbors, but you must realize that we have both the alternating and direct current equipment to contend with, and we have more trouble in the changing over from alternating current to direct current than in any other one particular feature of our operation, which would not happen if we had either system pure and simple. For the benefit of the steam men who have not had any more electrical experience than I had when I took hold of the New Haven system eight years ago, when it was just in the infancy of the electrification, I will say that we have seen many bugs picked out of that system, and we have been good missionaries for the rest of the steam lines which have got to come to electrification in some sense or another, and I will say that those men who are going up against electrification in these days are not justified in approaching the subject with that fear and trembling which was common some years ago. There is no reason why a man who is used to putting together two pieces of steel should not be able to put together two pieces of copper and put them back just as he found them before—there is no great complication to it, and it is merely a matter of keeping the apparatus in working order.

We should first define what is going to be a detention. There is no use in saying we shall have so many miles per detention, unless we define whether the detention is to be one minute, two minutes, or five minutes. Mr. Quereau has already, apparently, adopted two minutes as the period. Another man who

Table I

PRINCIPAL STEAM ROAD ELECTRIFICATIONS IN AMERICA

NAME OF ROAD AND SECTION ELECTRIFIED	Began Elec. Operation	Length of Route, Miles	Length of Track, Miles	System of Electrification	Number Locos.	Car Equipment	
						Motors	Trail
B. & O., Baltimore, Md., Baltimore Tunnels...	1895	3.75	8.4	675 V. D. C.	9	.....	.....
Long Island Ry.	1905	84.42	208.51	600 V. D. C.	.....	474	78
New York Central, Harmon, New York... ...	1906	54	255	600 V. D. C.	63	192	19
New York, New Haven & Hartford R. R., N. Y., New Haven	1908	99.61	537.94	Single Phase 11,000 V. 25 Cyc. 600 V. D. C., N. Y. C.	100	74	79
Grand Trunk Ry., St. Clair Tunnel Co., Pt. Huron, Mich., St. Clair Tunnel	1908	4	12	Single Phase 3300 V. 25 Cyc.	3 Units.	.....	.....
Great Northern R. R., Cascade Tunnel, Washington	1909	4	10	Three Phase, 6600 V. 25 Cyc.	4	.....	.....
Michigan Central, Detroit River Tunnel, Detroit, Mich	1910	4.4	25.7	600 V. D. C.	10	.....	.....
Penn. Tunnel & Term. R. R., P. R. R. into N. Y. City	1910	19.9	98.6	600 V. D. C.	68	68	.....
B. & M. R. R., No. Adams, Mass., Hoosac Tunnel	1911	7.92	22	Single Phase, 11,000 V. 25 Cyc.	5	.....	.....
Butte, Anaconda & Pacific R. R., Butte-Anaconda, Mont	1913	30	90.5	2400 V. D. C.	19 Frt., 2 P	.....	.....
Norfolk & Western R. R., Bluefield-Elkhorn, W. Va	Bldg. 1914	30	75	Split Phase, 11,000 V. 25 Cyc., A. C.	12	.....	.....
Canadian Northern, Montreal, Can	Bldg. 1914	9	25	2400 V. D. C.	6	8	.....
Pennsylvania R. R., Philadelphia to Paoli	Bldg. 1914	20.3	93	11,000 V. A. C.	.....	93	.....
C. M. & St. P.	Bldg. 1915	220	300	3000 V. D. C.	21	.....	.....

Abbreviations: V.—Volts. D. C.—Direct Current. A. C.—Alternating Current.

wants to make a good record will make it five minutes, and I think there should be some clear understanding as to what we will start with as a basis as a dentention.

FORGING SPECIFICATIONS

The committee feels that the following table expresses the maximum fiber stresses which should be used in heat-treated carbon and alloy steel materials for forgings, and therefore presents it to the Association as information, suggesting that it be submitted as Recommended Practice:

	Heat-Treated Carbon.		Alloy.	
	Tension and Compression.	Bending.	Tension and Compression.	Bending.
Main and parallel rods.....	10 000	14 000	12 000	17 000
Piston rods	11 000	15 000	13 500	18 000
Driving axles	.....	20 000	.....	24 000
Crank pins	.....	17 000	.....	20 000

The committee prepared a specification for alloy steel forgings of the chrome-nickel type. After consideration of the criticisms of this specification, and of the quenched and tempered carbon steel and alloy steel (chrome-vanadium type) specifications, the committee recommends the following:

(a) That the present standard specifications for quenched and tempered carbon steel axles, shafts and other forgings for locomotives and cars, be modified in accordance with the proposed specifications for quenched and tempered carbon steel forgings as submitted in Exhibit *A*. This in order to harmonize this specification with our alloy steel specifications and also include a recommended proof test.

(b) That the present specifications for alloy steel forgings, be modified as submitted in Exhibit *B*. This change consists

C. D. Young
Chairman, Committee on Forging Specifications

in adding to the present alloy steel specifications for chrome-vanadium, a chrome-nickel alloy and also a recommended proof test.

The report is signed by:—C. D. Young (Penn.), Chairman; A. H. Fetters (U. P.); H. B. MacFarland (A., T. & S. F.); J. R. Onderdonk (B. & O.); H. E. Smith (N. Y. C.); J. W. Taylor (Sec.), and Frank Zeleny (C., B. & Q.).

The principal difference between Exhibit *A* of the committee's report and the specifications referred to are in the chemical composition and the proof test. The chemical composition presented by the committee follows:

Chemical Composition.—The steel shall conform to the following requirements as to chemical composition.

Carbon	First class	0.38 —0.52 per cent.
	Second class	0.45 —0.60 per cent.
Manganese		0.40 —0.70 per cent.
Phosphorus	not over	0.05 per cent.
Sulphur	not over	0.05 per cent.

A paragraph was added under proof tests as follows:

(b) A recommended test for axles, shafts and similar forgings is as follows: Place the forging upon supports 3 ft. apart mounted on an M. C. B. drop test machine. The forging should then be struck two blows by a tup weighing either 1640 or 2240 lb. falling from heights proportioned according to the following formula and tabulation. Between the first and second blows the forging shall be turned 90 deg.

Height of drop in feet = $.01D^3$ for 1640-lb. tup.

Height of drop in feet = $.0073D^3$ for 2240-lb. tup.

NOTE.—D = Diameter of shaft or thickness of forging at center in inches.

Diameter of Shaft at center, inches.	Height of drop in feet. 1640-lb. tup.	2240-lb. tup.
5	1 ft. 3 in.	0 ft. 11 in.
5½	1 ft. 8 in.	1 ft. 3 in.
6	2 ft. 2 in.	1 ft. 7 in.
6½	2 ft. 9 in.	2 ft. 0 in.
7	3 ft. 5 in.	2 ft. 6 in.
7½	4 ft. 3 in.	3 ft. 1 in.
8	5 ft. 1 in.	3 ft. 9 in.
8½	6 ft. 2 in.	4 ft. 6 in.
9	7 ft. 3 in.	5 ft. 4 in.
9½	8 ft. 7 in.	6 ft. 3 in.
10	10 ft. 0 in.	7 ft. 4 in.
10½	11 ft. 7 in.	8 ft. 5 in.
11	13 ft. 4 in.	9 ft. 9 in.
11½	15 ft. 3 in.	11 ft. 3 in.
12	17 ft. 3 in.	12 ft. 7 in.
12½	19 ft. 5 in.	14 ft. 3 in.
13	22 ft. 0 in.	16 ft. 0 in.
13½	24 ft. 7 in.	18 ft. 0 in.
14	27 ft. 5 in.	20 ft. 0 in.
14½	30 ft. 6 in.	22 ft. 3 in.
15	33 ft. 9 in.	24 ft. 8 in.

NOTE.—The above heights are to the nearest inch.

The changes presented in Exhibit *B* are likewise in the chemical composition and in addition to the proof tests. The chemical composition is as follows:

Chemical Composition.—The steel shall conform to the following requirements as to chemical composition.

	Chrome Nickel.	Chrome Vanadium.
Carbon	0.28—0.42 per cent.	0.28—0.42 per cent.
Manganese	0.40—0.70 per cent.	0.40—0.70 per cent.
Silicon	0.10—0.30 per cent.	.....
Phosphorus, not over,.....	0.05 per cent.	0.05 per cent.
Sulphur, not over.....	0.05 per cent.	0.05 per cent.
Chromium	0.60—1.00 per cent.	0.75—1.25 per cent.
Nickel	1.00—1.50 per cent.	.....
Vanadium, not under.....		0.15 per cent.

[The addition to the proof tests is the same as given in Exhibit *A*.—Editor.]

DISCUSSION

C. D. Young: I move that the recommendations of the committee be submitted to letter ballot as recommended practice.

(The motion was carried.)

A. R. Ayers (N. Y. C.): Under Class *A* in the specifications for alloy steel forgings the committee includes piston rods which are subject to requirements of 10,000 lb. per square inch, less than axles, crank pins, etc. My recollection is that that was worded that way in the original alloy steel specifications, and was later corrected, so as to put piston rods in Class *B*, to get the benefit of the heavier requirements. It is not evident why piston rods should not be subject to just as good treatment as axles, and I would ask if there would be any objection to putting piston rods under Class *B*, with axles?

C. D. Young: Class *B* says "and other forgings." It was the thought of the committee, I believe, at the time this was discussed, that it might be well to keep piston rods, especially those which are hollow bored and forged, under Class *A*, and if desired they could be included as "other forgings" under Class *B*. I see no objection in specifically mentioning piston rods in both classes—the classes must take care of themselves by the expression of what they are supposed to cover.

BOILER WASHING

The committee in its endeavor to ascertain the general practice of washing locomotive boilers sent out a letter requesting answers to 20 questions. From 118 letters sent out replies were received from 93, representing 51,294 locomotives. The information received is summarized as follows:

2. Miles Made between Wash-outs.—9760 engines make less than 500 miles. 11,283 engines make over 500 and less than 1000 miles. 8312 engines make over 1000 and less than 1500 miles. 20,472 engines make over 1500 miles. 2467 not replying or unable to furnish information. The passenger locomotives make 30 per cent greater mileage between wash-outs than freight engines.

3. Water Changes.—Only about 5 per cent of the roads in the country practice changing water in the boilers.

4. Blowing Out at Terminals.—About 15 per cent practice some regular system of blowing boilers at terminals. About 35 per cent of the engines are blown out regularly and systematically while on the road to remove mud or sludge that may have accumulated in the boiler, and to prevent foaming.

5. Wash-out Holes in Boilers.—The maximum number of wash-out plugs reported in a boiler was 52, with a minimum of ten, or an average on all modern power of 32.

6. Cost of Washing Boilers.—This question was not thoroughly understood, as some roads only reported the cost of water. From the information gathered from the reports it costs about 35 per cent less to wash with hot water than it does with cold water.

7. Boiler Washing Pressure.—The average boiler washing pressure at the pump or line was 96 lb. and about 72 lb. at the nozzle.

8. Hot Water System for Washing Boilers.—Hot water systems were reported as being used on 54 roads, 13 being the maximum number reported on any one road. Some report using injector to heat washing and filling water.

9. Reduction of Water on Account of Hot Water Plants.—The use of hot water for boiler washing plants shows an average reduction in the amount of water used of 3427 gal. or 36 per cent, some roads reporting as much as 9000 gal.

10. Reduction in Amount of Time on Account of Hot Water Plants.—A reduction in time of 1 hr. and 54 min., or 42 per cent.

11. Saving of Fuel on Account of Hot Water Plants.—A saving in fuel of 897 lb., or 36 per cent.

12. Improvement in Performance of Firebox Sheets, Stays, etc., on Account of Hot Water Plants.—All roads except one report a great reduction in boiler troubles, especially as to cracked sheets, leaky stays, etc., or an average reduction in these troubles of 34 per cent.

13. Water-treating Plants.—Thirty-one roads report using water-softening plants at wayside tanks.

14. Treating Water in Engine Tanks.—Forty-five roads report using chemicals in engine tenders, 19 using soda ash and 26 boiler compound.

15. Treatment to Prevent Incrustation.—Seventy-six roads report using boiler compound, soda ash and other chemicals, to prevent incrustation.

John Purcell
Chairman, Committee on Boiler Washing

16. Treatment to Prevent Foaming.—Twenty-nine roads report using boiler compound or other chemicals to prevent foaming.

17. Treatment to Prevent Corrosion and Pitting.—Very few roads specifically treat water to prevent corrosion, but water treatment as explained in answers to Questions 13, 14 and 15, often prevents corrosion of sheets, flues, etc.

18. Increased Repairs to Packing, Cylinders, etc., Due to Water Treatment.—Seven roads report water treatment increasing repairs to valves and packing, due principally to boiler foaming. Others report no increase in repairs.

19. Increased Mileage Due to Water Treatment.—All roads using water-softening plants report great increase in mileage between flue setting and boiler repairs, some roads reporting as high as 300 per cent. An average increase in mileage of over 100 per cent is given.

20. Experience in Handling Mechanical Water Purifiers.—None of the roads report using mechanical water purifiers. Some report as having experimented in the past, but not using same at the present time.

Rules.—Sixteen of the roads report having regular rules governing the washing of boilers, and the majority report that they comply simply with the Interstate Commerce Commission's instructions as to washing boilers.

In further explanation of the above answers, washing boilers depends entirely on the water conditions. A number of roads report running 30 days, while other roads in the so-called bad water section report the necessity of washing out every 100 miles.

In explanation of answer to Question 4 in reference to blowing out, while some roads have regular systematic methods of blowing out boilers at terminals, the majority seem to leave it entirely with the engine crew. It has been demonstrated on two or three roads using water which foams badly that with the intelligent use of anti-foaming boiler compound and a liberal use of blow-off cocks, a locomotive could be run 2000 miles or more without foaming trouble. Better results are obtained if the boiler is blown out while not using steam, or after engine has been standing a while.

As to Question 6, the cost of washing boilers, as stated, this question was evidently misunderstood. With the large modern boilers where engines are thoroughly washed, it is evident from this report that this can not be thoroughly done for less than $3.50, where cold water is used, both for cooling down and washing out, and where scraper is used and loose scale removed.

Question 14. Treatment of water in engine tanks.—This practice is more prevalent on divisions where they have one or two bad water stations, the other water on the division being good. All the roads report a great improvement in boiler maintenance where water softening is practiced, either in wayside tanks or where chemicals are used in the engine tenders.

Owing to the great difference in conditions under which locomotives are operated it is felt that the subject can be successfully treated only in a general way, and the following method of washing boilers is given at this time as being a good general practice:

METHOD OF WASHING BOILERS.

Frequency of Washing.—All locomotives in service must have boilers washed at least once every thirty days, or more frequently if conditions require.

Cooling Boilers.—Boilers should be thoroughly cooled before being washed, except at points where improved hot water wash-out systems are installed. When boilers are cooled in the natural way without the use of water, the steam should be blown off, but the water must be retained above the top of the crown sheet and the boiler allowed to stand until the temperature of the steel in the firebox is reduced to about 90 deg., or so that it feels cool to the hand; then the water is drawn off and the boiler washed. When the engine can not be spared from service sufficiently long for it to be cooled in this manner before washing, proceed as follows:

Use of Injector for Cooling Boilers.—When there is sufficient steam pressure, start the injector and fill the boiler with water until the steam pressure will no longer work the injector. Then connect water-pressure hose to feed pipe between the engine and tender and fill the boiler full, allowing the remaining steam pressure to blow through the syphon cock or some other outlet at the top of the boiler. Open blow-off cock and allow the water to escape, but not faster than it is forced in through the check, so as to keep the boiler completely filled until the temperature of the steel in the firebox is reduced to about 90 deg.; then remove all plugs and allow the boiler to empty itself.

How to Wash a Boiler.—Remove all wash-out plugs. Begin washing through the holes on the side of the boiler opposite the front end of the crown sheet. Wash the top of the crown sheet at the front end, using Nozzle No. 1 or 2. Then use Nozzles 3 and 4 to wash between the rows of crown bars and bolts at right angles to the nozzle, directing the stream toward the back end of the crown sheet. After washing through the holes near front end of the crown sheet, use the holes in their respective order toward the back of the crown sheet. The object of this method is to work the mud and scale from the crown sheet toward the side and back legs of the boiler and prevent depositing it on the back ends of the flues.

Washing Crown Sheet.—Next wash the crown sheet from the boiler head, using Nozzles 1 and 3 or 6. When Nos. 3 or 6 are employed, the swivel connection with the hose should be used and the nozzle should be inserted to the front end of the crown sheet and slowly drawn back and revolved at the same time, so as to wash the top of the boiler and all the radial stays or bolts as well as the crown sheet.

Washing Flues.—Wash the back end of the flues through the holes in the connection sheet, using Nozzles Nos. 1, 5 and 6, and revolve them by means of a swivel connection when the curved nozzles are used. The same nozzles are to be used and the same system followed when washing any part of the flues or feed-water heater flues.

Washing Back Head Water Spaces.—Wash the water space between the back head and the firebox door sheet through the holes in the back head with Nozzle No. 6, being careful to remove all scale and mud above and below the fire-door hole.

Washing Arch Tubes.—Arch tubes must be washed and scraped

clean with scrapers or pneumatic cleaners every time the boiler is washed. If scale is allowed to form in the arch tubes the metal becomes overheated and bulges are formed, and, if allowed to remain, the tube warps out of line with the holes, strains are set up and cracks develop, and the tube is very dangerous and liable to pull out or explode. Therefore a locomotive should not be allowed to leave a terminal with dirty arch tubes, and all concerned are instructed to strictly comply with the rule.

NOTE.—The condition of an arch tube as to scale on the water side can readily be determined by the presence of clinker adhering on the fire side.

Washing Side-sheet Water Spaces.—Now return to the holes on the side of the boiler opposite the crown sheet, using Nozzles 5 and 6, and revolve them so as to thoroughly wash down the side sheets and staybolts, making sure that all spaces on the side of the firebox are clear of mud and scale. Then wash through the holes near the check valves near the front end of the boiler, using Nozzles 1 and 5 or 6, with a swivel connection.

Washing Barrel or Boiler.—Then wash through the hole in the bottom of the barrel of the boiler near the rear end, and wash toward the front end. If the engine has no mud drum, wash toward the throat sheet with Nozzles 5 or 6. Then use the straight nozzle directly against the flues, reaching as great a space as possible in all directions. Then use the bent nozzle through the front hole in the bottom of the barrel, and also the straight nozzle in same manner as above, until certain that the flues and spaces between the flues and the barrel are as clean as it is possible to make them.

Washing Mud Ring.—Then use Nozzles Nos. 5 and 6 in the side and corner holes of the water legs, revolving them thoroughly to clean the side sheets, and finally clean off all scale and mud from the mud ring by means of straight nozzles in the corner holes.

Inspection after Washing.—It must not be assumed that because clear water runs from the holes that the boiler is cleaned, but all spaces must be examined carefully with a rod and light, and, if necessary, use a pick, steel scraper or other tools, to remove accumulated scale.

Filling Boilers.—When cooling and filling boilers, they must be filled through the injector check. The injector steam pipe valve at the fountain must be closed. Filling up boilers through blow-off cocks will not be permitted except at hot water boiler washing plants and when hot water is being used.

Fig. 1 shows the nozzles referred to above. Experience shows that wash-out nozzles should be smooth and constructed so as to throw a solid stream out of a 5/8-in hole with 100 lb. pressure back of it for a distance of 10 or 12 ft., which gives a very effective washing force. The aim is to have 100 lb. pressure at the nozzle, which can usually be had by having 125 lb. at the pump; this varies somewhat according to pipe lines. Fig. 2 shows a scraper and an oil and electric inspection torches.

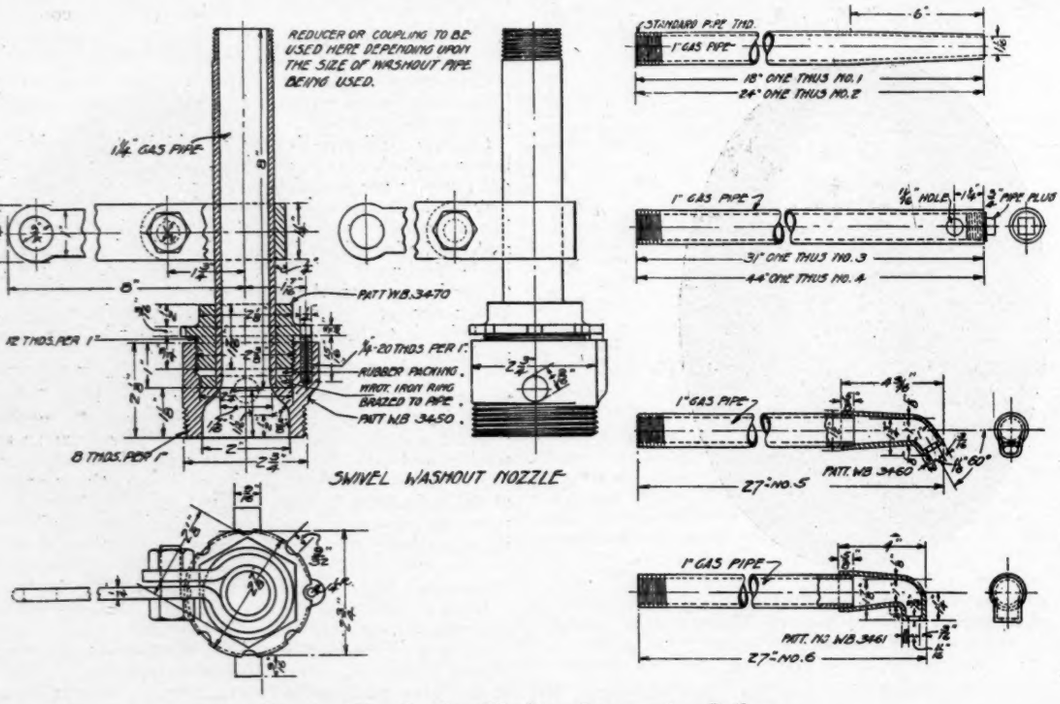


Fig. 1.—Nozzles for Washing Locomotive Boilers

HOT WATER BOILER WASHING PLANTS.

The Santa Fe System has given some accurate and reliable figures on the cost of washing boilers with both hot and cold water. That road uses both the hot and cold water boiler washing systems, having one Gordon, three National and seven Santa Fe hot water wash-out plants. Their figures show, with the cold water wash-out system (not including overhead charges), a cost of $4.42 to handle a modern locomotive boiler; this includes cooling from 100 lb. steam pressure, emptying, washing, filling, firing up and raising the steam pressure to 100 lbs., also the cost of water and fuel. It requires not less than 5 hours' time for the operation, while with the hot water system a boiler can be emptied, washed, filled, fired up and steam raised to 100 lb. pressure for $3.01, including the cost of water and fuel. A saving of $1.41, and a reduction in time of about 1½ hours for each engine.

The operation of changing water in a boiler with the cold water plants costs $3.54, with the hot water plants $2.13, a water change being only 88 cents cheaper than a wash-out with either system. The following is a detailed statement of the various items involved:

COST OF BOILER WASHING, COLD WATER WASHING SYSTEM.

A modern boiler, 100 lb. steam; 4 in. of water in glass.

Cooling to 90 deg. F., cooling water 57 deg. F., 9000 gal. at 4 cents per 1000 gal.	$0.36
Time cooling and draining boiler 2 ft. 30 in. at 20 cents per hr., one man	.50
Removing and replacing plugs, two men, 30 min., 40 cents per hr.	.20
Washing boiler, two men, 1 hr., at 40 cents per hr.	.40
Water used washing boiler, 3000 gal. at 4 cents per M. gal.	.12
Water used filling boiler, 4000 gal. at 4 cents per M. gal.	.16
Time filling boiler, 45 min., 1 man at 20 cents per hr.	.15
Laying fire bed, 1000 lb. coal, 10 cents per 100 lb.	1.00
Additional fuel to raise steam to 100 lb. boiler pressure, 1100 lb.	1.10
Time of fire builder, 45 min.	.15
Add 20 per cent. to time of men for changing tools from engine to engine	.28
Total	$4.42

COST OF BOILER WASHING, HOT WATER WASH-OUT SYSTEM.

A modern boiler, 100 lb. steam; 4 in. of water in glass.

Blowing steam and water out of boiler, one man, 1 hr.	$0.20
Removing and replacing plugs, two men, 30 min., 40 cents per hr.	.20
Washing boiler, two men, 1 hr at 40 cents per hr.	.40
Water used washing boiler, 3000 gal., 4 cents per M. gal.	.12
Water used filling boiler, 4000 gal., 4 cents per M. gal.	.16
Time filling boiler, 45 min., one man at 20 cents per hr.	.15
Laying fire bed, 1000 lb. coal, 10 cents per hundred.	1.00
Additional fuel to raise steam to 100 lb. boiler pressure, 500 lb. at 10 cents per 100 lb.	.50
Time of fire builder, 30 min., at 20 cents per hr.	.10
Add 20 per cent. to time of men for changing tools from engine to engine	.18
Total	$3.01

The saving in water and fuel of the hot water over the cold water system depends on how well the hot water plant is oper-

ated. A well-kept hot water boiler washing plant is a certain economy, while a poorly operated and maintained plant may be conducted at a loss. The temperature of the boiler washing water should be maintained not less than 130 deg. and the filling water as much hotter as it can be obtained without the use of live steam. Reservoirs of ample capacity should be provided to conserve heat which may be collected from various sources, other than that blown out by locomotives and which can profitably be applied in heating the washing or filling water for locomotive boilers.

The Central of Georgia reports making some tests on cost saving and time saving on boiler washing with hot water wash-out systems as compared with cold water. These tests were followed up accurately by the testing engineer, with watch, actual weights on fuel, and actual consumption of water by use of meter. The saving in boiler maintenance and repairs, as well as flue and firebox failures on the line of road, shows a decided improvement when engines are washed with the mechanical hot water system as compared with cold water system. For instance, on this road, with average water conditions, since installing hot water washing outfit the life of the flues has been practically doubled. The life of fireboxes, staybolts and boiler sheets shows a material improvement. Failures on account of leaky flues and fireboxes have been practically eliminated, and, last but not least, the mileage of engines between wash-outs has been doubled. Under these circumstances the saving in boiler and flue repairs is, conservatively, $200 per locomotive per year, with the hot water system as compared with cold water. In the bad water districts these figures would show considerable increase. With the outfit at the Macon engine-house piped to 17 pits, it is necessary to only wash out two engines per day to show an actual money saving on the investment of 5.7 per cent. An outfit for average small enginehouse could be installed for $7500.

Average time taken per engine in blowing down, min.	70	73⅓	78
Total number of engines washed.	177	189	181
Average temperature of washing water, degrees	189	177½	177
Average time taken per engine in washing, min.	25	25½	27
Total number of engines filled.	174	222	223
Average temperature of filling water, degrees	210	207¼	211
Average time taken per engine in filling, min.	26	24⅓	24¾
Total number of engines fired up.	189	217	218
Average time taken per engine in firing up to 100 lb. steam, min.	46	43	41
Average extra consumption of water per boiler washed out, gal.	No record.	1753⅛	1732⅔

The condition under which these tests were made require that all the blow-off water from the locomotive boilers be utilized again for washing and refilling. This plant has been in service one year and no live steam has ever been used for heating water. The cost of boiler washing with this system is approximately as follows:

AVERAGE COST OF BOILER WASHING—HOT WATER SYSTEM.

Blowing steam and water out of boiler	1 man, 15 min.	@ $0.22	$0.055
Remove and replace plugs	2 men, 30 min.	@ .22	.220
Washing boiler	2 men, ½ hr. ea.	@ .22	.220
Water used washing boilers	1 500 gal.	@ .08	.120
Water used filling boiler	No charge.		
Time filling boiler	1 man, 30 min.	@ .22	.110
Laying fire bed, 1 000 lb. coal (Bit.)		@ 2.00 net	1 000
Additional fuel to raise steam to 100 lb. pressure 500 lb. (Bit.)		@ 2.00 net	.500
Time of fire builder	1 man, 45 min.	@ .175 hr.	.131
			$2.356

This road reports that this plant is very economical and that nothing has been spent for repairs to the plant during the past year. The plant has a total water capacity of 60,000 gal., 30,000

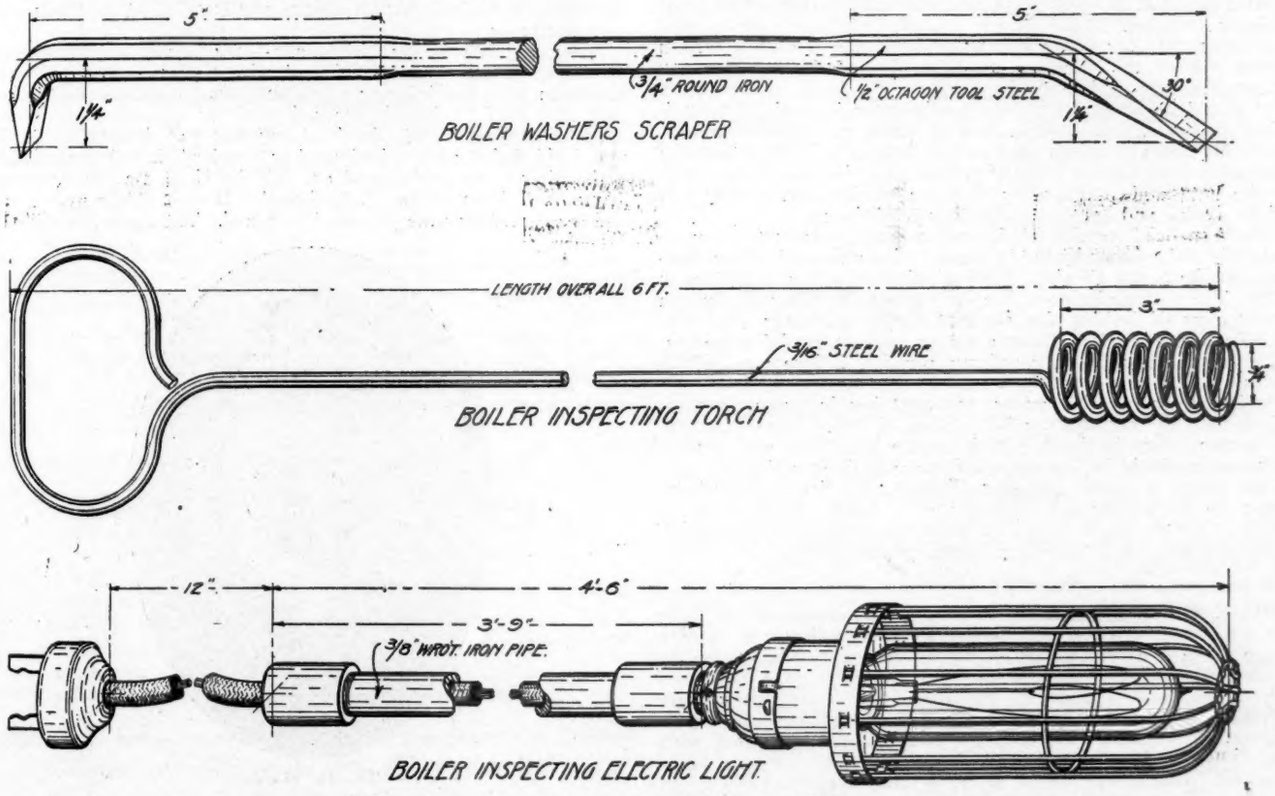


Fig. 2.—Scraper and Inspection Torches for Washing Boilers

There is in operation at the Communipaw roundhouse, of the Central Railroad of New Jersey, at Jersey City, N. J., a Winter's boiler wash-out plant. The plant consists of two standard 3-in. cypress tanks, one submerged within the other. The outside tank forms the hot well in which the locomotives are blown off; the inside tank contains the water for refilling. The following data indicate results of tests made at this plant from September 1, 1914, to November 30, 1914:

	Sept. 1 to 30.	Oct. 1 to 31.	Nov. 1 to 30.
Total number of engines put through plant for any purpose	202	228	226
Total number of engines blown down	179	203	197
Average steam pressure per engine on boiler at time of blowing down, lbs.	103	110	108

gal. of which is in the hot well, 18,000 gal. in the refilling tank, and 12,000 gal. in the cold water storage.

[A copy of the instructions for washing boilers as used by the Pennsylvania Lines was also included.—Editor.]

WATER TREATMENT TO PREVENT INCRUSTATION.

The Santa Fe, which has more water softening plants in operation than any other road, reported: The Santa Fe went into the water treatment in the latter part of 1903, since that time 115 water treating plants have been established. The lowest incrustants before treatment in any water treated is 16.6 gr. per gal. The highest incrustants before treatment is 80.9 gr. per gal. The average cost of water treatment on the Santa Fa is 3¼ cents per 1000 gal. The average amount of incrustants in all waters before

treatment for 1912 was 31.6 gr. The average amount of incrustants after treatment was 3.2 gr. The average amount of incrustants removed was 28.4 gr. The amount of incrustants removed per 1000 gal. was 4.05 lb. Total 1000 gal. treated, 4,050,367. Total pounds incrustants removed 16,708,728.

The incrusting matter in boiler waters consists almost entirely of carbonates of lime and magnesia and sulphates of lime and magnesia. The carbonates require treatment with hydrated lime and the sulphates require soda ash. Any system of water softening to be effective must work within certain prescribed limits, such as automatic means of proportioning the correct amount of chemicals to the water should be provided. The water should have not less than four hours' time in which to complete the reaction and settle out the precipitates.

There are two general classes of water softening plants on the market: one known as the "Continuous" and the other as the "Intermittent" system. There are advantages in both systems, but on the whole it is considered that the Continuous system is preferable on account of requiring less floor-space and also less labor and fuel charges for the additional pumping.

There are a number of factors which should be considered when deciding whether or not to build a water softening plant. As a rule little is gained by putting up a single plant here and there over the division. Treatment of only a small fraction of the waters can not possibly result in the preventing of the formation of all scale, and these plants always get the blame for any foaming troubles which arise on that division, whether justly or not.

Soda ash applied in an engine tender has this disadvantage that the water in the engine's tender becomes partly treated and will, with high sulphate, throw down its solids at a reasonably low temperature, and in many cases the temperature of the injector is sufficient to do this and the result is rapid incrustation of injector, injector parts, and connections, and increase of injector troubles. This tender treatment is therefore a very poor substitute for water softening plants, but will to a certain extent relieve the situation on those branch lines where the waters are only moderately hard.

It would be profitable, where much water is used, to treat it when the incrusting solids exceed 12 grains per gallon. This is especially desirable where treated waters may be on both sides of untreated water tanks, for the reason that the incrusting solids in the untreated water, after they are precipitated, greatly add to the sludge and aggravate foaming conditions.

The beneficial results of following water treatment may be approximately shown by the increase in flue mileage between failures on the Santa Fe since the beginning of water treatment in 1903. The mileage between flue failures on the Santa Fe System on account of leaking for the last eight months in 1903 was 17,557 miles. This has shown a steady increase until for the first eight months for 1914 the mileage per flue failure was 168,624 miles.

It is safe to say that water treatment has in many cases increased the life of fireboxes 300 per cent, it being considered that the improvement in the flue performance represents very largely a correspondingly improved performance in firebox sheets.

The report is signed by:—John Purcell (A., T. & S. F.), Chairman; W. H. Fetner (C. of Ga.); J. C. Little (C. & N. W.); W. P. Carroll (N. Y. C.); G. W. Rink (C. of N. J.); E. S. Fitzsimmons (Erie), and G. E. Sisco (Penn. Lines).

DISCUSSION.

W. E. Dunham (C. & N. W.): For those of us who have to deal with particularly bad water conditions, it hardly seems as if it would be necessary to outline a set of rules, as presented here, but that is the fact, and not very long ago we outlined a set of rules very similar to these, and the results obtained from being systematic and thorough in your washing out of boilers, even though you are not equipped with the latest and most expensive requirements of hot water washout plants and all of such details, are all well worth while. I have usually specified that the roundhouse foreman of either the day or night force should inspect the boiler after it was washed out, and by doing that we have been able to eliminate flue failures and fire-box failures where we had them before, and had lots of them. There is only one variation which I found necessary from the plan here outlined, and that is under our local conditions we have found it very necessary to wash from the front of the boiler back through the flues first, and then follow the procedure practically as Mr. Purcell has outlined it here. We have a very heavy accumulation of mud and scale, and we believe it is advisable to get that off of the flues first, and then we finish up with that the last. In other words, we give our flues a double washing, you might say, and we find it pays exceedingly.

D. R. MacBain (N. Y. C.): The importance of good washing out I do not believe would be questioned by any person, excepting it was some superintendent or trainmaster who thought the engine did not need washing out, and the progress that has been made in the past ten years in that very important part of the maintenance of the locomotive is something I am sure every member of the Association appreciates. The paper might be taken safely by any member of the Association as a text, and I wish to say further that following it in the finest detail outlined you will not be going too far so far as the interest of the company is concerned. I move that the paper be accepted as read, and be submitted to letter ballot as recommended practice

Mr. Dunham: References are made to certain nozzles in the report. If the wording of the outline could be changed so that the nozzles would be designated as a "right angled nozzle" or a "straight nozzle" or something of that kind, it would be of little more general use than the detail shown here. With that change I would second Mr. MacBain's motion.

Mr. MacBain: That is agreeable.

(The motion was carried.)

O. C. Wright (Penna. Lines): I would like to call attention to the boiler inspection electric light. It is shown with a brass socket connected to wrought iron pipe. We have had some experience with a similar inspection light and found that on account of the fact that the lamp was subjected to moisture and mechanical abuse it was almost impossible to keep it free from ground, which makes it a very unpleasant as well as a rather dangerous lamp to handle. We have designed and are using a lamp of very similar construction to this, with a porcelain socket sealed in and attached to a fibre tube. We have gotten very good results from this lamp.

FLANGE AND SCREW COUPLINGS FOR INJECTORS

The committee has endeavored to decide upon standards for flange and screw couplings which can be adopted for locomotive service with the least inconvenience and expense to railroads and manufacturers.

Form and Dimensions of Threads.—Analysis of the statements of the roads which communicated with the committee and cooperation with the injector manufacturers led to the conclusion that a pitch of 10 threads per inch could be adopted as a future common standard with the least expense to all concerned. It was decided that a thread adopted as standard should interchange with either a sharp V-thread or with the U. S. standard thread. A modified form of the U. S. thread will meet this requirement and is suggested as the proposed standard. The form and dimensions of this proposed thread are shown in Fig. 1. These threads are proposed for all injector connections, including the overflow, as well as for all couplings used throughout the injector piping system, whether of the nut or flange type.

M. H. Haig
Chairman, Committee on Dimensions of Flange and Screw Couplings for Injectors

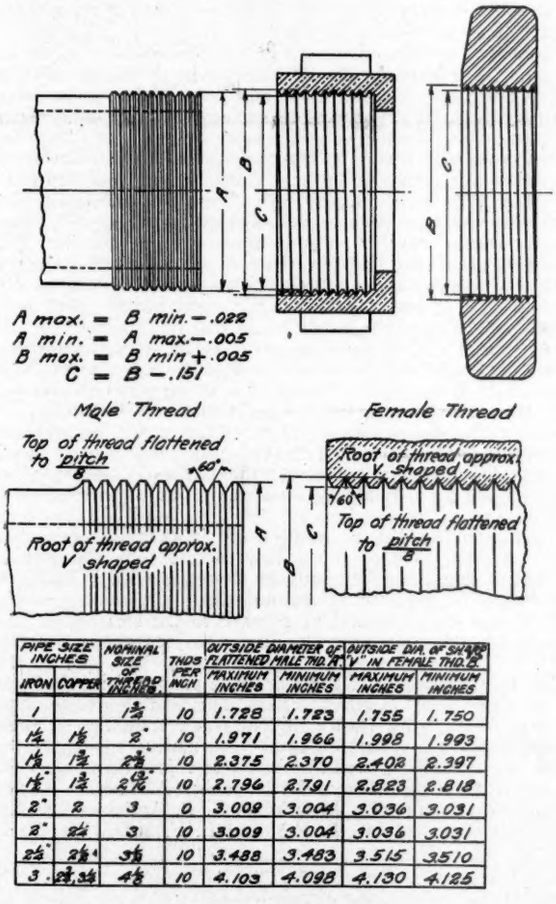
Coupling Nuts and Sleeves.—As a result of investigation it is believed that certain sizes of nuts can be selected as standard for certain sizes of iron and copper pipe. On the same principle it is believed that certain sizes of sleeves (collars or tail pieces) can be adopted as standard for use with definite sizes of nuts and pipes. The proposed standard dimensions of these coupling nuts and sleeves are shown in Fig. 2. The proposed standard forms of the nuts and sleeves are shown in Fig. 3.

It is proposed that each manufacturer shall continue the size of

pipe considered most satisfactory for his injector, but the couplings for each size of pipe shall conform to the proposed standard threads and dimensions.

Unfortunately, injector nuts are sometimes subject to rough handling by tightening them with improper tools. To resist improper handling and to provide against nuts being stretched by tightening or cracked by pounding, the proposed standards include dimensions for greater thickness throughout than found common in past practice. It is proposed that the outside of injector coupling nuts shall be left rough, except in the grooves.

In planning proposed standard dimensions for sleeves, various sizes were considered by which it might be possible to make the sleeves thicker. Making the sleeves thicker than in the past would increase their diameter. This in turn would require a greater diameter of nuts used with given sizes of pipe. Such increases in diameter of nuts would prevent interchangeability with previous equipment where interchangeability between proposed standards and much old equipment would otherwise be possible. With the possible exception of the sleeve for 1½-in. copper pipe it is believed that the sleeves shown for use with copper pipes are of reasonable thickness. Injectors on locomotives in present railroad service are seldom, if ever, equipped with 1½-in. copper pipe. This size, in all probability, will gradually become obsolete. The committee, therefore, does not regard it as of sufficient importance to justify any radical change.


A max. = B min. − .022
A min. = A max. − .005
B max. = B min + .005
C = B − .151
Male Thread
Female Thread
Top of thread flattened to pitch
Root of thread approx. V shaped
60°
Root of thread approx. V shaped
Top of thread flattened to pitch

PIPE SIZE INCHES		NOMINAL SIZE OF THREAD INCHES	THDS PER INCH	OUTSIDE DIAMETER OF FLATTENED MALE THD. A		OUTSIDE DIA. OF SHARP "V" IN FEMALE THD. B	
IRON	COPPER			MAXIMUM INCHES	MINIMUM INCHES	MAXIMUM INCHES	MINIMUM INCHES
1		1 5/8	10	1.728	1.723	1.755	1.750
1¼	1⅛	2"	10	1.971	1.966	1.998	1.993
1½	1⅜	2 3/8"	10	2.375	2.370	2.402	2.397
1⅝"	1¾	2 42/100"	10	2.796	2.791	2.823	2.818
2"	2	3	0	3.009	3.004	3.036	3.031
2"	2⅛	3	10	3.009	3.004	3.036	3.031
2½"	2⅛"	3 5/8	10	3.488	3.483	3.515	3.510
3	2⅞, 3⅛	4⅛	10	4.103	4.098	4.130	4.125

Fig. 1.—Proposed Standard Form and Dimensions of Threads for Injector Couplings. Ten Threads per Inch.

Application of Coupling Sleeves.—The committee favors copper pipe extending throughout the full length of the sleeve under all conditions. When the pipe is brazed, its end should be belled out to fill the chamfer shown at upper end of each sleeve for copper pipe in Fig. 1. This application is shown by Fig. 4. Under no circumstances should a sleeve be counterbored for a portion of its length and a copper pipe fitted into this short counterbore and brazed. Another practice to be avoided is that of brazing a short ring on the end of a copper pipe instead of applying a proper sleeve.

A collar 1¼ in. long is considered of ample length with either a mechanical joint or brazing. It is not probable that a longer surface will be thoroughly brazed throughout its entire surface.

The sleeves for use with iron pipes as shown in Fig. 1 are considered of reasonable thickness. It will be observed that the inside diameter of the sleeve is shown by the sketches to be smaller in many cases than the inside diameter of the pipe. This is done to provide ample thickness in the sleeve.

Dimensions of Flange Couplings.—Where flange couplings are used the threads should conform to the shape, dimensions and pitch shown in Fig. 2 and the sleeves used with flange couplings

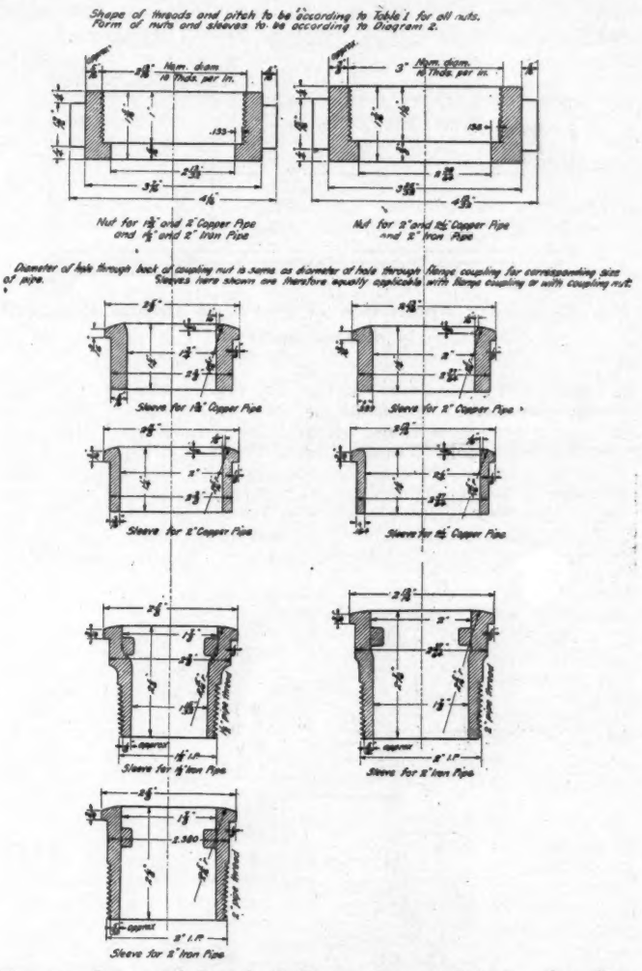

Shape of threads and pitch to be according to Table 1 for all nuts.
Form of nuts and sleeves to be according to Diagram 2.
Nut for ⅞" and 1" Copper Pipe and ¾" and 2" Iron Pipe
Nut for 2" and 1¼" Copper Pipe and 2" Iron Pipe
Diameter of hole through back of coupling nut is same as diameter of hole through flange coupling for corresponding size of pipe. Sleeves here shown are therefore equally applicable with flange coupling or with coupling nut.
Sleeve for ⅞" Copper Pipe
Sleeve for 1" Copper Pipe
Sleeve for 1¼" Copper Pipe
Sleeve for 1½" Copper Pipe
Sleeve for ¾" Iron Pipe
Sleeve for 2" Iron Pipe
Sleeve for 1" Iron Pipe

Fig. 2.—Proposed Standard Dimensions of Injector Coupling Nuts and Sleeves

should conform to the dimensions shown in Fig. 1 for the respective sizes of pipe. The dimensions of flange couplings of the different manufacturers have been compared and considered with the dimensions of connections submitted by the various railroads.

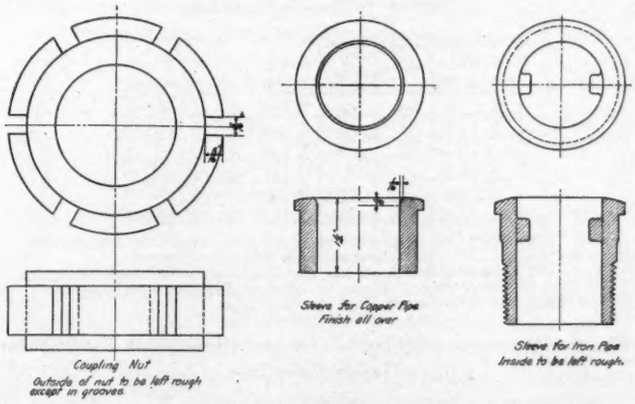

Coupling Nut
Outside of nut to be left rough except in grooves
Sleeve for Copper Pipe
Finish all over
Sleeve for Iron Pipe
Inside to be left rough.

Fig. 3.—Proposed Standard Forms of Coupling Nuts and Sleeves

This investigation has led to the proposed standard form and dimensions of flange couplings shown, Fig. 5. To provide against any possible weakness due to blow holes, porous metal or other defects in cast steel, it is recommended to make the flanges

of forged steel. It is believed that the little additional cost of drop forgings will be justified.

Typical examples were shown of mechanical joints now in service on a few roads to which equipment of dimensions shown in Fig. 5 are applicable with the pipe secured by beading over the end or by brazing. The hole through the flange is of the same diameter as the hole through the coupling nut, and, consequently, fits the same sleeve for a given size of pipe.

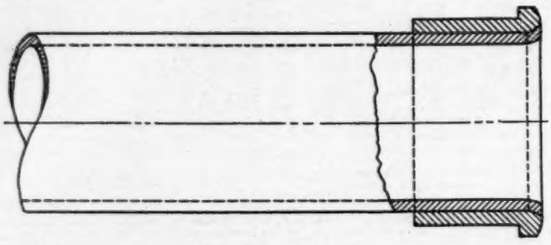
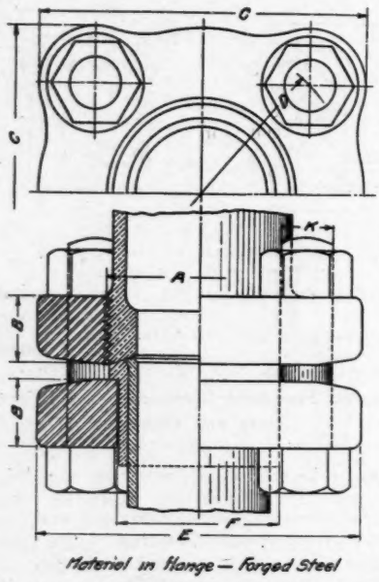


Fig. 4.—Proper Application of Sleeve to Copper Pipe with Brazed Joint

Brazed and Mechanical Joints.—The replies made by the roads to the committee's questions, as well as the prints submitted, indicate a very general use of the brass spanner nut. The most common practice is to braze a brass sleeve to a copper pipe and to screw a brass sleeve to the iron pipe. Of the 36 roads communicating with the committee, 31 report using brazed joints only and 5 report using some joints that are not brazed. Among the 31 are 2 roads which chamfer the end of the sleeve and expand or bell the end of pipe into the chamfer. This supplements the brazing and the roads using it report this practice as quite satisfactory.

The 5 roads which report joints without brazing, extend end of pipe through nipple and bead over the end of pipe so that it forms a ball joint. As to comparison between the brazed and mechanical joints, most of the roads are noncommittal, having had no experience with the mechanical joint. Several of these roads state very definitely that the brazed joints are thoroughly satisfactory and have led to no complaint. With regard to recommending mechanical joints as standard, nine roads definitely vote "no" and two "yes."



Material in Flange — Forged Steel

PIPE SIZE INCHES IRON	PIPE SIZE INCHES COPPER	NUMBER OF THREADS PER INCH	NOMINAL DIAMETER OF THREADS A INCHES	B INCHES	C INCHES	D INCHES	E INCHES	F INCHES	K INCHES
1½	1⅝	10	2	7/16	3 7/16	3 11/16	3 15/16	1 13/16	5/8
1¾	1¾	10	2 3/16	1/2	3 5/8	3 7/8	4 1/16	2 1/16	11/16
1¼, 2	1⅜, 2	10	2 7/16	9/16	4 1/16	4	4 1/4	2 9/16	5/8
2	2, 2⅛	10	3	5/8	4 1/2	4 1/2	4 3/4	2 7/16	5/8
2½	2½	10	3 1/2	5/8	5 1/2	5	5 1/2	3 3/16	5/8
3	2⅝, 3⅛	10	4 1/16	5/8	5 3/8	5 3/8	5 5/8	3 5/16	3/4

Dimension F of flange coupling is same as diameter of hole through coupling nut for corresponding size of pipe, shown by diagram 1.
Sleeves secured by beading over end of pipe are of the same dimensions as those secured by brazing. Equipment of above dimensions are, therefore, applicable with either method of securing pipe.

Fig. 5.—Proposed Standard Form and Dimensions for Injector Flange Couplings

Flange Connection as Compared with Spanner Nut.—Twenty-four roads reply definitely "No" to the question as to whether the flange connection is favored in preference to the spanner nut. A road using spanner nuts in connection with lifting injectors and the flange connection with non-lifting injectors, reports both as satisfactory where used. Another comment is worthy of quoting in full: "Have never used flange connection. While it is possible the flange connection would not be as subject to leaks as a coupling nut and nipple, these joints are broken so many times that the ease with which the coupling nut connection can be taken apart we believe outweighs any advantage to be gained with the flange."

Material in Coupling Nuts and Sleeves.—Spanner nuts and sleeves are commonly made of brass. A number of compositions, some more or less alike, were reported by various railroads. The following composition impresses the committee as a satisfactory mixture:

Copper	84 to 86 per cent.
Zinc	4 to 6 per cent.
Tin	4 to 6 per cent.
Lead	4 to 6 per cent.

Spelter.—In brazing, the usual practice of spelter with borax flux is commonly followed. A mixture of fifty per cent copper and fifty per cent zinc seems to be the most commonly used.

Brazing by Oxy-acetylene Process.—A shop of one road reported doing all brazing by the oxy-acetylene process. The reply is quoted, in part, as follows: "Since adopting this practice we have had very good success with it; in fact, have not had one joint leak where it was brazed, and we do not find that it oxidizes the zinc in the brass or causes joint to become porous. We find it saves a great deal of time. In fact, we can braze pipes by this method in five to eight minutes which would otherwise take thirty minutes with charcoal fire. In the eight months that we have been using this process we have not had one failure."

Application of Injector Equipment.—The water feed or suction pipe in particular should be thoroughly clamped. Injectors should be properly bolted to stiff brackets. Steam pipes should be bent with easy curves and the bends should not be abrupt. It is necessary that due allowance be made for expansion and contraction and it is the opinion of the committee that a bend approaching a reverse curve meets requirements most satisfactorily. The bends in the pipe should be on a radius of at least from 10 in. to 14 in.

Lever Starting Valve Support.—It is recommended that the lever starting valve of non-lifting injectors be clamped to the boiler and that the valve body be designed with a lug to facilitate this. To support valves not already provided with such lugs, a rigid clamp should be secured to the steam pipe immediately below the starting valve and one just above the starting valve.

Use of Standards.—If the standards proposed by this committee are to be adopted, the votes deciding this should be cast with the idea of applying future injectors and couplings accordingly. If the question is voted on in the affirmative without intending to use the standards, it will be better to reject them.

The report is signed by:—M. H. Haig (A. T. & S. F.), Chairman; T. F. Barton (D., L. & W.); S. B. Andrews (S. A. L.); W. H. Winterrowd (C. P. R.), and B. F. Kuhn (N. Y. C.).

DISCUSSION.

Mr. Haig (Chairman): The preparation of a set of standards naturally incurs more or less inconvenience and expense. It was therefore the effort of the Committee to decide upon standards which would result in the smallest amount of expense, hardship or inconvenience upon the railroads or the manufacturers. The manufacturers were invited to co-operate with the committee and were urged to be present at all meetings. Representatives of some manufacturers attended all the meetings.

J. Strickland Knease (Wm. Seller & Sons): I acted as chairman of the committee of manufacturers to discuss this subject and it was considered from the same point of view as your committee, with the idea of reducing the number of threads to the minimum, and at the same time obtain the strongest form which would be of service. Certain recommendations which were made by the manufacturers committee were not accepted. The principal one to which I wish to call your attention is the pitch of thread. It further desired to reduce the variety of coupling nut thread and pitches as much as possible, each manufacturer willingly sacrificing his own design if he considered it obselete. I would therefore ask consideration of certain recommendations in Mr. Haig's report with which I do not agree, stating that my opinion is supported by two large manufacturing companies who also have had wide experience along these lines.

In regard to coupling nuts: Your committee advocates a uniform pitch of ten threads per inch. The manufacturers' committee thinks it preferable to increase the pitch with the diameter of the nut within certain limits, on account of the difficulty of properly fitting fine threads with large diameters, and the danger of crossing the threads when the nuts are partially worn. For these reasons the manufacturers' committee recommends and is prepared to supply nuts and branches threaded eight per inch for all diameters, 3 inches and above, in accordance with standard nuts in use on railroads since 1876.

Your committee accepted the recommendation of the manufacturers' committee covering the special shape of thread. The writer brought this form of thread to the attention of the association in the discussion of Mr. Foster's paper last June, which was designed in 1890, and has been used ever since and corresponds almost exactly to the standards. The manufacturers' committee also think that your committee has made the coupling nuts unusually heavy. There is sufficient metal now in the nut if properly designed. If cast with the mixture given in the committee's report, an eight per inch nut for 2½ inch iron pipe will stand a strain of 30,000 to 35,000 lbs. before yielding at the collar. It would be therefore entirely unnecessary to increase the thickness or width of the nut, especially as the increasing cost of copper, tin and zinc would add materially to the expense. Another detail is the radius of the ball joint. I should say without going into detail that the ball joint as designed is rather flatter than the accepted standards, and both standards are proving entirely satisfactory. The general practice of the foreign roads, especially the English, is to use much more conical joints than we do.

As to brazing unions, I would say that the form of brazing ring has been re-designed. Some roads prefer the brazed connection in order to meet the improved form of brazing ring. Your committee recommends a counter bore of the brazing ring itself. The committee of manufacturers made tests of the brazed union which show that the cause of failure was due to lack of penetration of the brazing material between the copper pipe and the ring. For that reason they recommend a counter bore of the rings to a point within its head and the bevelling of the lower face to permit slight flanging of the copper pipe toward the ball joint. This counter bore leaves a space of about 1/64 in. on each side to permit the brazing material to run down to the collar of the brazing ring, adding materially to the strength of the joint. The breaking strength of the joint runs from 17,000 to 22,000 lb.

The Vice-President: Mr. Haig, would your committee like to have another year with the Manufacturers' Association to present something that we could go on as recommended practice?

Mr. Haig: Mr. Knease's presenting his remarks as the representative of the Manufacturers' Committee was somewhat of a surprise to me, for the reason that I do not understand his statements to agree with those of individual representatives who have discussed this matter with me.

I think that the matter which Mr. Knease presented to-day would have been to much better advantage presented at the meetings at which he was urged to be present.

The tables which he presents were thoroughly investigated and discussed by the railroad men, as well as by the representatives of manufacturers, and it was agreed that his old standards would not be as satisfactory as those which the reports from the railroads indicated to be the more common.

S. G. Thomson (P. & R.): It does not seem to me, mechanically, that ten threads is right for a ⅜ in. pipe, if it is right for a 3 in. pipe. Of course you can make the threads heavy enough to prevent trouble, but we have had a great deal of trouble from fine threads on large pipe. It seems to me that there ought to be some division, say ten threads up to 2 inches, and eight threads above. I move that this committee be continued and come together and give us another report next year.

(The motion was carried.)

SUBJECTS

The Committee on Subjects for the 1916 meeting of the Association submits the following report:

That the present standing committees be continued.

That the following subjects be assigned to special committees:

1. Equalization of long locomotives, so as to secure the most effective guiding from the trucks, both leading and trailing.
2. Best practice and type of tender truck for passenger locomotives. Has a swing truck any advantage over a rigid truck?
3. Reciprocating and revolving weights. Committee to report on possibilities of lightening.
4. Transmission of electric power from motors to driving wheels of electric locomotives. Committee to report on the progress in this direction.
5. Use of pyrometers on superheater locomotives.
6. Piston valves, rings and bushings. Best material and sizes, with particular reference to superheated steam.
7. Metal pilot designs.
8. Modernizing existing locomotives, which can then remain in service for ten or fifteen years.

That the following subjects be assigned for topical discussions:

1. Advantages, if any, of compounding superheater locomotives.
2. Side bearings on tenders.
3. Tender derailments: Causes and remedies.
4. Road instruction for enginemen and firemen.
5. Crosshead design.

The report is signed by:—A. W. Gibbs (Penn.), chairman; D. R. MacBain (N. Y. C.), and C. E. Fuller (U. P.).

The report of the committee was received and each subject was referred to the incoming committee.

CONCLUDING EXERCISES

The following officers were elected for the ensuing year: President, E. W. Pratt (C. & N. W.); first vice-president, William Schlafge (Erie); second vice-president, F. H. Clark (B. & O.); third vice-president, W. J. Tollerton (C. R. I. & P.); treasurer, Angus Sinclair. The following executive members were elected: C. H. Hogan, (N. Y. C.); J. F. De Voy, (C. M. & St. P.) and J. T. Wallis, (Penn.).

W. E. Symons, in presenting retiring-president Gaines with a past-president's badge said:

The year which has just closed, the fiscal year of this association, has been a very trying one to all railway companies, by reason of questions of economy, valuation and various other matters with which railway officers have to deal, and placing heavy burdens on the leaders of the motive power departments of our railways and upon officers of associations like this who have to devise ways and means for reaching these economies. Our retiring President, Mr. Gaines, has been no exception to the rule in this respect, and his activities have only reflected honor and credit to himself. It has been customary on past occasions to present the retiring president with a jewel indicating the degree of esteem and affection in which the members of the Association hold him as a man, as an engineer, as an executive officer, and as a citizen, and on this particular occasion the duty of making the presentation of this jewel has fallen upon me.

I take great pleasure, Mr. Gaines, in presenting to you the past president's badge, which you receive as the retiring president of this association, and to say to you that it embodies in part our estimation of you as an executive officer, as an engineer and as a railway man, and our esteem and consideration for you as a citizen. I have also noted with much pain and sympathy your present slight physical indisposition, but we hope, and I feel justified in saying to you, that if the affectionate regard in which you are held by the members of this Association has any curative properties, you will be almost immediately restored to your perfect good health, and that we will have the benefit of your wise counsels in years to come.

SAFETY WATER GLASS COCK

A newly developed water glass cock is being exhibited by the Sargent Company, Chicago, which automatically drains the water from the glass when either or both top and bottom cocks are closed. With the ordinary type of cocks used on water glasses, it is possible to trap water in the glass by inadvertently closing both cocks, the indication of a false water level being thereby made possible. Should either one of the cocks be closed or should they be only partially open a similar dangerous condition is produced.

The new water glass cock is designed to prevent occurrence of these conditions. It contains a double seated valve, one side of which controls the passage from the boiler to the glass, and the other side a passage from the glass to the atmosphere. When the boiler passage is closed the outlet is open, and vice versa. Should either valve be open at the boiler connection while the other is closed the pressure will cause a flow through the glass and thence out through the open cock. When both boiler connections are closed the glass will drain through the lower cock. The arrangement is such that it is necessary to fully open both valves in order to close the passage from the glass to the atmosphere, and it is impossible to operate with cracked valves, as is frequently done when ordinary cocks are used.

COMPARATIVE REGISTRATION FIGURES

In studying the following figures of registration to Friday morning it must be remembered that, so far as railroad men are concerned, the numbers for this year should be compared with those of 1913 and 1911, when M. M. Association met first. Compared with 1913 their is a falling off of 16 in railroad men (members and special guests), but a very considerable falling off—368—in the number of supply men.

	1911.	1912.	1913.	1914.	1915.
Members M. M. and M. C. B.	562	294	459	506	448
Special Guests	251	278	235	249	230
R. R. Ladies	387	238	289	237	233
Supply Ladies	325	186	256	234	188
Supply Men	1469	1297	1405	1275	1037
Totals	2319	2293	2644	2501	2136

ADDITIONAL MASTER MECHANICS' REGISTRATION

Bosworth, W. M., M. E.; L. & N.
Byron, A. W., M. M.; P. R. R.
Caracristi, V. Z., Conslt. Engr.; Blenheim.
Chidley, Joseph, A. S. M. P.; N. Y. C.; Blenheim.
Conniff, P.; Shop Supt.; B. & O.; Craig Hall.
Crawford, C. H., A. E. Mech. Dept.; N. C. & St. L.; Blenheim.
Cromwell, O. C., M. E.; B. & O.; Runnymede
Durham, H. P., S. M. P.; Tehauntepec Nat.; Westminster.
Gallaway, A. K., M. M.; B. & O.; Dennis.
Gardner, Henry, Chalfonte.
Gelhausen, F. R., Gen. For.; B. & O.; Lexington.
Gillis, H. A., Seaside.
Hill, Rufus, M. M.; P. R. R.
Jackson, O. S., Gen. Supt.; C. T. H. & S. E.; Blenheim.
Macbeth, H. A., S. M. P.; N. Y. C. & St. L.; Traymore.
Marsh, F. E., A. M. M.; P. R. R.
Miller, T. E., M. M.; B. & O.; Haddon Hall.
Oviatt, H. C., A. M. S., N. Y., N. H. & H.; Blenheim.
Thomas, I. B., S. M. P.; P. R. R.; Brighton.
Walsh, J. F., M. E.; Galena Signal Oil Co.; Chalfonte.

ADDITIONAL MASTER CAR BUILDERS' REGISTRATION

Calkins, A. E., A. S. H. S.; N. Y. C.; Traymore.
Chamberlain, J. T., Ex-Pres.; Alamac.
Chidley, Joseph, A. S. M. P. & R. S.; N. Y. C.; Blenheim.
Covert, M. F., A. M. C. B.; Swift Refr. Trans. Co.; Traymore.
Crawford, C. H., A. E. Mech. Dept.; N. C. & St. L.; Blenheim.
Cromwell, O. C., M. E.; B. & O.; Runnymede.
Fox, Geo. P., Gen. For.; N. Y. C.; Pennhurst.
Gillespie, W., M. C. B.; Cent. Vt.; Schlitz.
Hill, Rufus, M. M.; P. R. R.
Jackson, O. S., Gen. Supt.; C. T. H. & S. E.; Blenheim.
Macbeth, H. A., S. M. P.; N. Y. C. & St. L.
Meyers, H. E., M. M.; L. V.; Dennis.
Osman, H. L., S. C. D.; Morris & Co. Refr. Lines, Traymore.
Sasser, J. W., S. M. P.; Norfolk So.; Sterling.
Shackford, J. M., Ch. Draftsman, D., L. & W.; Blenheim.
Thomas, F. H., V. P.; Bellefonte Cent.; Stalton.
Thomas, I. B., S. M. P.; N. Centl.; Brighton.
Walsh, J. F., Chalfonte.
Young, J. P., Gen. For.; Mo. Pac.; Alamac.

ADDITIONAL SPECIAL GUESTS

Anderson, Harry A., Special Agent, P. R. R.
Anderson, J. B., Ch. Cl.; P. R. R.; Runnymede.
Barton, Ed. O., Gen. For.; P., B. & W.; Shelburne.
Bardo, C. L., Gen. Mgr., N. Y., N. H. & H.; Blenheim.
Bateman, Frank B., Atlantic City Ry.
Bates, John J., Foreman, P. & R.
Beatty, J. B., Ch. Cl.; P. R. R.; Dunlop.
Beck, I. H., For. Air Brake; C. of N. J.
Borcia, E., Engineer, Roumanian Government; Blenheim.
Boyer, John O., Rd. For. of Engs.; P. & R.
Burns, R. C., Insp.; P. R. R.; Haddon Hall.
Callahan, A. E., Gen. Tool Insp.; Erie; Alamac.
Carter, G. H., Gen. For.; P. & R.; Norwood.
Cornwell, D., Prest.; Wash. Georgetown Nav. Co.; Blenheim.
Cotton, Wm. A., Ch. Cl. to G. M. S.; Erie; Blenheim.
Cloward, T. T., Gen. For.; P., B. & W.; Chalfonte.
Crawford, M. R., For.; C. of N. J.; Louvan.
Cromwell, E. G., Insp. M. P.; B. & O.; Lexington.
Davis, G. L., Gen. For.; C. of N. J.
Deems, W. A., M. M.; B. & O.; Haddon Hall.
Detro, A. E.; Gen. For.; C. of N. J.; Traymore.
Demarest, G. L., Gen. For.; C. of N. J.; Dennis.
Doarnberger, J. A., Mast. Boiler Maker; N. & W.; Dennis.
Dodds, T. D., Secy. to S. M. P.; B. & O.; Holmhurst.
Duncan, J. H., P. & R.; Chester Inn.
Eliot, H. H., A. M. M.; P., B. & W.; Chalfonte.
England, Albert C., U. S. Navy; Bothwell.
Faber, George F., Gen. Supt.; P. R. R.
French, Ernest L., Gang For.; P. R. R.; Devonshire.
Carey, W. S., Sten. Office G. S. M. P.; Penn. Lines.
Gearhart, J. F., Gen. For.; P. R. R.; Dunlop.
Gettys, H. L., Mech. Insp.; N. & W.; Traymore.
Goodman, J. D., For.; P. R. R.; Newfield.
Griswold, W. W., Pur. Agt., W. & L. E.; Blenheim.
Hogsett, J. W., Ch. Insp.; Chalfonte.
Holliday, Howard, Monticello.
Jackson, R. E., M. M.; Va.; Arlington.
Jones, L. M., Asst. to Gen. Mgr.; Norfolk So.; Blenheim.
Kemmer, Nicolai, M. E.; Imperial Russian Rys.; Brighton.
Kidd, C. M., Insp. Gen. A. B.; N. & W.; Traymore.
King, R. W., Gen. Mgr.; Wash.-Va.; Haddon Hall.
Koch, C. B., Gen. For.; P. R. R.; Traymore.
Loughery, M. C., P. & R.
Lowther, H. F., Asst. P. A.; D. L. & W.; Craig Hall.
MacWhorter, Harlan, Atlantic City Ry.
Mahoney, J. E., Gen. Stork.; Norfolk So.; Blenheim.
Mayer, F. A., Gen Mast. B. M.; So.; Pennhurst.
McGinty, Geo. G., Secy.; I. C. C.; Haddon Hall.
Meason, H. M., Gen. For.; P. R. R.
Nagle, Benj. J., Gen. For.; P. & R.; Newfield.
Nagle, Geo. W., Gen. For.; P. & R.; Newfield.
Nation, James D., Trav. Engr.; P. R. R.
Perkinson, T. F., A. M. M.; B. & O. R. R.
Pilcher, Wm., Jr., N. & W.; Dennis.
Plummer, A. M., For. P. W. R. Sta.; W. J. & S.
Phetteplace, L. H., Gen. Mgr.; C. C. & O.; Traymore.
Rhett, E. M., Elec. Engr.; C. of Ga.; Chelsea.
Rives, E. A., For.; Southern; Lexington.
Rommell, C., For. Eng. House, Atlantic City Ry.
Rosenberg, C. R., Insp.; P. R. R.
Rotenberry, H. T., P. & R.; Devonshire.
Salisbury, R. W., M. E.; T. & P.; Traymore.
Sandhas, H. L., A. B. Insp. & Instr.; C. of N. J.; Arlington.
Sampson, W. F., M. P. Insp.; P. R. R.
Schechter, L. M., Ch. Engr.; Russe Loco. Corp.; Blenheim.
Schramm, F. J., Ch. Cl. to S. M. P. & E.; D., L. & W.; Alamac.
Seiders, Irwin A., Insp. Fuel; P. R. R.
Seddon, E. F., For. Mach. Shop, P. & R.; Edson.
Sharpley, J. E., Chf. Elecn.; Va.; Arlington.
Shannon, J. M. F., Clerk, P. R. R.; Dixie.
Shelton, F. M., Supt. Loco. Supplies, D., L. & W.; Alamac.
Stedd, Frank E., Supt.; L. V. C. Co.; Continental.
Stephens, J. H., Supt. Shops; Wash. Ry. & Elec. Co.
Stocker, Louis, Ch. Cl. to M. M.; P. R. R.
Stratton, G. E., Insp. Pass. Equip.; P. R. R.; Blenheim.
Sullivan, J. P., Gen. For.; C. of N. J.
Temple, J. S., Insp. Gen. Pc. Wk., B. & O.; Haddon Hall.
Torback, F. S., Gen. For.; B. & O.; Wittel.
Voorhees, T. C., P. & R.; Traymore.
Westley, J. S., Gen. For.; P. & R.; Blenheim.
Wilson, C. L., I. C. C.; Arlington.
White, Geo., Store Kpr.; P. R. R.
Wightman, F. A., M. P. Insp.; P. R. R.; Dennis.
Wood, P. O., Supt. Loco. Perf.; St. L. & S. F.; Traymore.

W. V. TURNER'S LATEST IMPROVEMENT IN BRAKING EQUIPMENT

Walter V. Turner, chief engineer, Westinghouse Air Brake Company, is attending the conventions this year. His most recent contribution to the art of transportation is the variable load brake and the variable road accelerator for electrically operated cars. The equipment of the New York Municipal Railway Corporation is provided with these features, which, with the electro-pneumatic brake, has permitted obtaining a capacity over four times as great as compared with the ordinary electric trains operated with the perfected air brakes. Mr. Turner has recently been made a fellow of the Royal Society of Arts in England.

MOTOR CARS IN INDIA.—Motor cars are extensively used in India, there being about 2000 in Calcutta and 1000 in Bombay. Values of exports of cars to India in the fiscal year 1913-14 are stated as follows: Motor cars, $3,680,855; motor-cycles, $346,490; motor wagons, $185,165; parts and accessories, $761,257. The United Kingdom leads in these items with the United States second.

Conventionalities

Harry Coddington, engineer of tests of the Norfolk & Western, was delayed two days in reaching the convention, because of the arrival of a little girl at his home.

C. W. Cross is accompanied by his son, who has just finished his special apprenticeship course at the Elkhart, Ind., shops of the New York Central. The trip is in the nature of a reward for the good record he has made.

The new cane sported yesterday by E. W. Kavanagh, of Ryerson & Son, attracted considerable attention. It was supplied at the expense of J. B. Warren, who fell down badly on a little matter of figures.

Frederic Schaefer, who recently organized the Schaefer Equipment Company, is attending the convention in the inter-

John Carroll (B. & O.) Admiring His Own Work

ests of his new company. Mr. D. Schaefer was formerly connected with the Summers Steel Car Co.

Henry Gardner, well known because of his work in the development of the modern apprenticeship system and improved shop organization, has Mrs. Gardner and his seven-year-old daughter, Elizabeth, with him this year.

The M. M. and M. C. B. Associations have established a reputation as the star orange juice consumers. The lady at the drinking fountain at the entrance to the Blenheim says her heaviest business of the year is during these conventions.

Mrs. Walter H. Bentley was detained at home this year on account of an operation performed about a month ago. She is convalescing rapidly and desires to be remembered to the many friends she made at the 1914, her first convention.

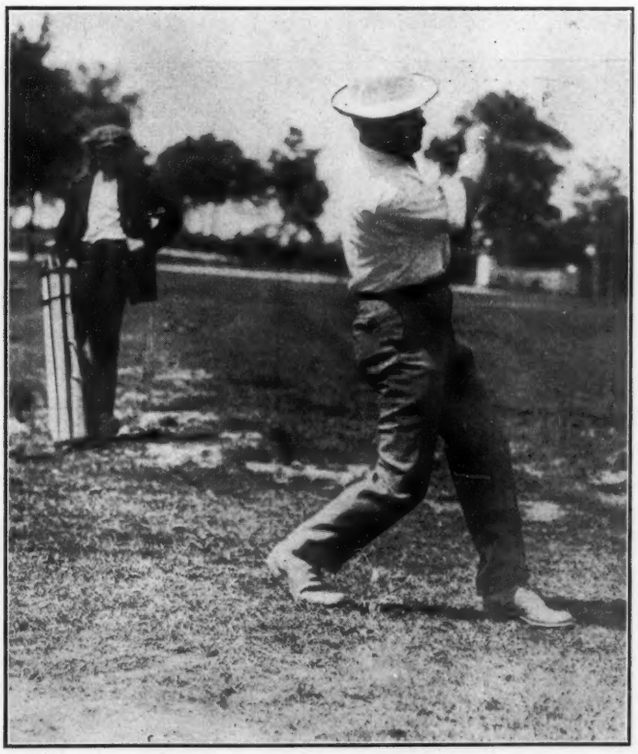
C. L. Bardo, general manager of the New York, New Haven & Hartford, is one of the convention visitors who are taking much interest in the exhibits. Needless to say, now that he is here, he intends to play in the golf tournament on Sunday.

Jack High is located just across the aisle from Herman Ball. Ed. Walker in passing by spoke to both of them. Contrary to his usual habit, he was quite dignified and used their last names. "My goodness," said an elderly lady who was

Frank J. Barry, M. M., N. Y. O. & W.

passing at the time, "I didn't realize that they had 'high-balls' on the pier."

George B. McGinty, secretary of the Interstate Commerce Commission, and a party of the locomotive boiler inspectors of the commission are here for the conventions. The party includes, Frank McNanamy, chief inspector; G. P. Robinson and A. Pack, assistant chief inspectors, and Inspector Scudder, Mil-



M. K. Barnum, S. M. P., B. & O., Had Put Some "Pep" Into It

waukee; Boltwood, Denver; Adair, St. Louis; McNanamy, Grand Rapids; Wilson, Memphis; Wintersteen, Philadelphia, and Phfaeler, Washington. Next week seven of the commission's safety appliance inspectors will arrive to attend the Master Car Builders' convention. They will be headed, as usual, by

Chief Inspector H. W. Belnap. Mr. McGinty is this year accompanied to the conventions for the first time by Mrs. McGinty. He expects to remain at least until Monday.

It is remarkable how quickly the Lake Shore crowd have become accustomed to the new order of things. Not a single

T. F. Barton, M. M., D. L. & W., and Mrs. Barton

one of them stirred when President Gaines called for some one from the Lake Shore to give certain data as to conditions on that road. When M. D. Franey was singled out he started off in this fashion: "Speaking for the fourth district of the New York Central, etc."

Among those here is E. Borcea, of Roumania. In normal times he is a railway man, being identified with the construction department of the Roumania Government Railways. Recently, however, he was transferred to the War Office and is in this

J. J. Carey, M. M., Texas & Pacific

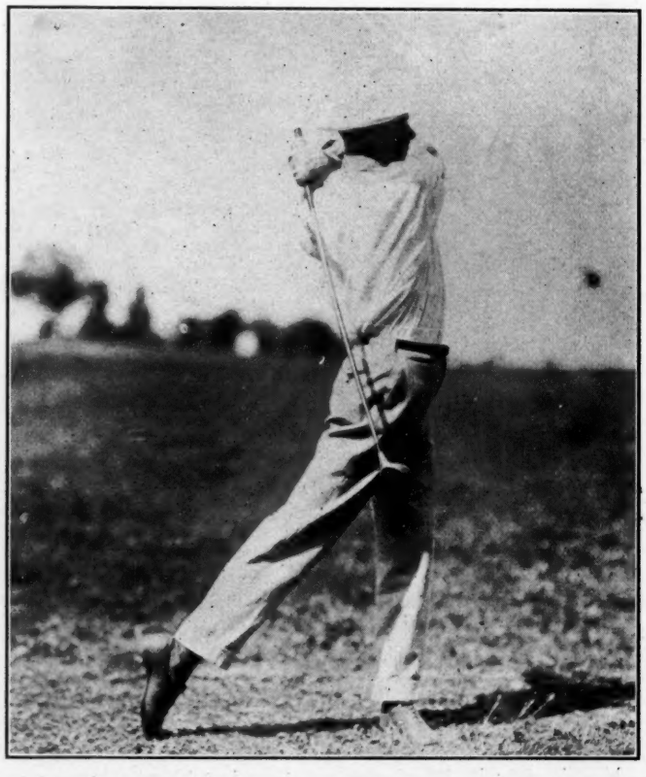
country with a captain of artillery looking into the possibilities of getting munitions of war. This is Mr. Borcea's second convention, he having attended in 1913.

C. W. Beaver, manager hoist department, Yale & Towne Manufacturing Company, who recently returned from a business trip to Cuba, reports that business there is in a very flourishing condition, the principal contributing cause being the demand for sugar. So long as the European war lasts the beet sugar output of the East will be very small. It is probably this increased demand upon the sugar market of Cuba that has made it necessary for the Havana Central to go into the market for 600 freight cars and 10 cabooses.

George A. Post narrated an incident the other night which he says explains several things. He is to be the orator this year at the commencement exercises of a small academy from which he graduated a greater or less number of years ago. When the announcement was made that he was to speak, the editor

C. S. Adams, Asst. Gen. For., New York Central

of a local paper, who was the editor of it also at the time he graduated, and who is a quite venerable gentleman now, sent Mr. Post a copy of an academy entertainment program in which the latter had a part years ago. In this entertainment several of the students took the part of animals, one being a dog,



C. C. Elmes, Assistant Engineer Motive Power, Philadelphia & Reading, at the end of a drive

another a cat and "Georgie" Post being a goat. "I wrote him in reply," said Mr. Post, "thanking him for recalling this entertainment to me and adding that the fact that I began to take that part so early explained many things in my subsequent career."